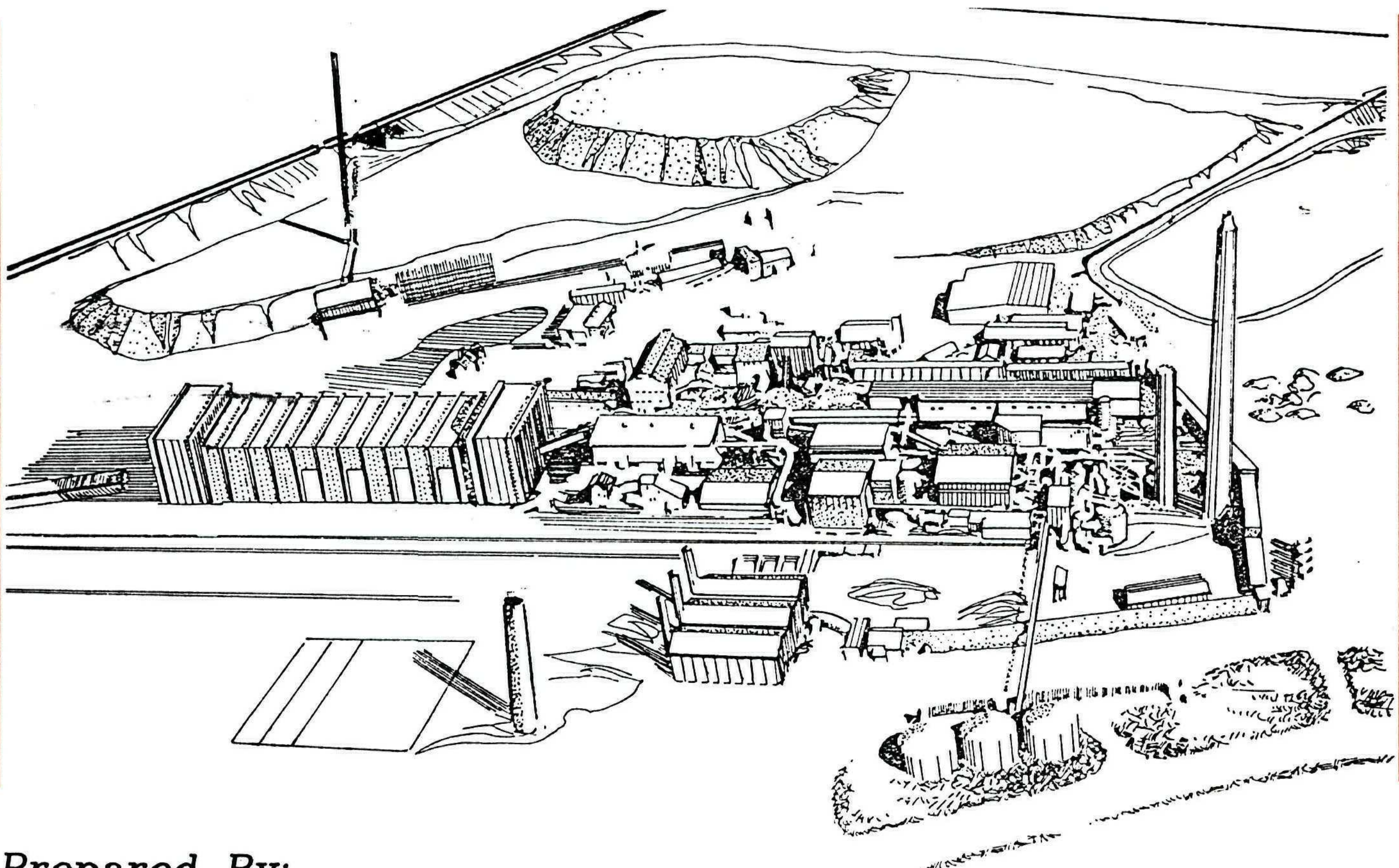
Volume 5

Comprehensive Remedial Investigation/Feasibility Study - ASARCO, Inc. East Helena, Montana



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APPENDIX 5-2-3

SUMMARY OF STREAM BOTTOM SEDIMENT ANALYSES

0211103

SUMMARY OF STREAM BOTTOM SEDIMENT ANALYSIS - ASARCO EAST HELENA

SAMPLING SITE	PPC-3	PPC-3	PPC-3	PPC-3	PPC-4	PPC-4	PPC-4	PPC-5	PPC-5	PPC-5
SAMPLE DATE	11/07/84	11/07/84	05/08/85	05/08/85	11/06/84	11/06/84	05/07/85	11/06/84	11/06/84	11/06/84
LAB	ASARCO	CAL	ASARCO	JTC	ASARCO	CAL	ASARCO	ASARCO	ASARCO	CAL
REMARKS									REPLICATE	
SAMPLE NUMBER	8411-21	8411-21	8505-430	8505-430	8411-22	8411-22	8505-431	8411-23	8411-39	8411-23
TRACE ELEMENTS										
ALUMINUM (AL)		1110		2470		1060				2040
ANTIMONY (SB)	<10	<0.7	<10	<35	<10	<0.7	<10	<10	<10	1.0
ARSENIC (AS)	12	50	10	10.3	12	0.44	13	84	30	20
BARIUM (BA)	50	18	60	45	50	16	80	115	125	26
BERYLLIUM (BE)		0.1		<3.3		0.12				0.18
CADMIUM (CD)	1.0	0.6	1.0	5	1.0	0.5	1.5	19	7.5	5.5
CHROMIUM (CR)	80	2.3	95	<5.4	140	2.1	35	65	85	2.7
COBALT (CO)	<10	1.7	<10	<14	10	1.7	10	10	<10	2.0
COPPER (CU)	25	14	23	11	30	7.5	28	165	95	34
IRON (FE)	15100	2960	16750	6780	25250	3390	17250	29500	28500	4300
LEAD (PB)	70	34	60	57	85	22	75	1450	380	284
MANGANESE (MN)	950	247	1150	1143	1450	225	1050	1300	1350	325
MERCURY (HG)	0.65	<0.1	0.050	<0.1	0.45	<0.1	0.070	4.6	0.85	0.65
NICKEL (NI)		<1.7		<12		<1.7				<1.7
SELENIUM (SE)		<0.12		<2.7		<0.12				<0.12
SILVER (AG)	<2.5	0.8	<2.5	<6.5	<2.5	<0.13	<2.5	7.5	5.0	1.9
THALLIUM (TL)		0.13		<1.8		<0.1				0.15
TIN (SN)		2.1		<23		4.5				<1.8
VANADIUM (V)	<100	6	<100	<23	<100	6.5	<100	<100	<100	8
ZINC (ZN)	195	105	185	248	220	86	250	950	525	212

ALL QUANTITIES IN PARTS PER MILLION UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED

OUTPUT DATE: 12/18/85

SUMMARY OF STREAM BOTTOM SEDIMENT ANALYSIS - ASARCO EAST HELENA

0211104

SAMPLING SITE	PFC-5	PFC-5	PFC-6	PFC-6	PFC-6	PFC-7	PFC-7	PFC-7	PFC-8	PFC-8
SAMPLE DATE	11/06/84	05/07/85	11/05/84	11/06/84	05/07/85	11/05/84	11/05/84	05/07/85	11/05/84	11/05/84
LAB	CAL	ASARCO	ASARCO	CAL	ASARCO	ASARCO	CAL	ASARCO	ASARCO	CAL
REMARKS	REPLICATE									
SAMPLE NUMBER	8411-39	8505-432	8411-24	8411-24	8505-433	8411-25	8411-25	8505-434	8411-26	8411-26
TRACE ELEMENTS										
ALUMINUM (AL)	2980			1750			2690			2220
ANTIMONY (SB)	<0.7	<10	<10	<0.7	<10	<10	<0.7	<10	<10	<0.7
ARSENIC (AS)	16	20	29	28	31	51	60	46	42	17
BARIUM (BA)	46	75	70	33	100	90	60	140	125	90
BERYLLIUM (BE)	0.24			0.15			0.24			0.22
CADMIUM (CD)	1.6	2.5	6.0	3.8	6.0	5.0	2.1	9.5	16	1.1
CHROMIUM (CR)	3.6	45	75	26	115	60	4.8	70	90	3.8
COBALT (CO)	4.1	<10	10	3.2	<10	10	5	14	12	6
COPPER (CU)	32	48	85	45	120	120	65	195	165	80
IRON (FE)	7200	20000	19500	4380	33000	27500	8100	34750	33250	12000
LEAD (PB)	100	190	360	182	400	410	230	630	555	540
MANGANESE (MN)	445	1150	1250	600	1700	1150	498	1750	1800	950
MERCURY (HG)	0.15	0.12	0.65	0.25	0.42	0.69	0.2	0.90	1.1	0.33
NICKEL (NI)	2.9			25			2.8			1.9
SELENIUM (SE)	<0.12			<0.12			<0.12			<0.12
SILVER (AG)	0.85	<2.5	<2.5	1.6	3.5	3.5	1.3	6.0	2.5	2.2
THALLIUM (TL)	<0.1			0.28			0.37			0.26
TIN (SN)	<1.8			<1.8			1150			<1.8
VANADIUM (V)	14	<100	<100	6.5	<100	<100	13	<100	<100	9.5
ZINC (ZN)	228	400	1075	427	750	1350	1020	1125	2650	2920

ALL QUANTITIES IN PARTS PER MILLION UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED

OUTPUT DATE: 12/18/85

0211105

SUMMARY OF STREAM BOTTOM SEDIMENT ANALYSIS - ASARCO EAST HELENA

SAMPLING SITE	PPC-8	PPC-8	PPC-9	PPC-9	PPC-9	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE
SAMPLE DATE	05/07/85	05/08/85	11/05/84	11/05/84	05/07/85	11/07/84	11/07/84	11/07/84	11/07/84	06/06/85
LAB	ASARCO	ASARCO	ASARCO	CAL	ASARCO	ASARCO	ASARCO	CAL	CAL	ASARCO
REMARKS		REPLICATE					REPLICATE		REPLICATE	
SAMPLE NUMBER	8505-435	8505-405	8411-27	8411-27	8505-436	8411-36	8411-40	8411-36	8411-40	8506-528
TRACE ELEMENTS										
ALUMINUM (AL)				9100				6050	8050	
ANTIMONY (SB)	<10	<10	<10	<0.7	<10	<10	<10	0.75	<0.7	<10
ARSENIC (AS)	18	30	53	60	18	264	108	75	70	83
BARIUM (BA)	35	110	150	110	100	95	<25	65	122	115
BERYLLIUM (BE)				0.95				0.48	0.7	
CADMIUM (CD)	1.5	3.5	19	6	3.5	65	26	12	8	48
CHROMIUM (CR)	70	45	105	12	105	75	50	7	12	45
COBALT (CO)	<10	<10	12	6.5	<10	18	24	5.5	7.5	16
COPPER (CU)	38	70	135	75	80	330	290	112	115	280
IRON (FE)	16750	20000	35000	16800	25500	38750	48500	8600	23600	40500
LEAD (PB)	130	255	690	400	300	4150	1675	685	494	1350
MANGANESE (MN)	1300	1450	2850	1480	1650	900	1050	660	274	800
MERCURY (HG)	0.10	0.10	3.2	0.75	0.12	15	0.70	7.5	2.6	2.5
NICKEL (NI)				8.5				5.5	7	
SELENIUM (SE)				<0.12				<0.12	<0.12	
SILVER (AG)	<2.5	<2.5	4.0	3.7	<2.5	9.0	6.5	2	2.4	7.5
THALLIUM (TL)				0.50				0.65	0.42	
TIN (SN)				<1.8				<1.8	<1.8	
VANADIUM (V)	<100	<100	<100	26	<100	<100	155	20	34	<100
ZINC (ZN)	325	600	1650	1320	1425	2550	1700	825	461	2125

ALL QUANTITIES IN PARTS PER MILLION UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED

OUTPUT DATE: 12/18/85

SUMMARY OF STREAM BOTTOM SEDIMENT ANALYSIS - ASARCO EAST HELENA

0211106

SAMPLING SITE	UPPER LAKE	WD-2	WD-2	WD-2	WD-2	WD-2	WD-3	WD-3	WD-3	3
SAMPLE DATE	06/06/85	11/07/84	11/07/84	05/08/85	05/08/85	05/08/85	11/07/84	11/07/84	05/08/85	05/08/85
LAB	ASARCO	ASARCO	CAL	ASARCO	ASARCO	JTC	ASARCO	CAL	ASARCO	JTC
REMARKS	REPLICATE				REPLICATE					
SAMPLE NUMBER	8506-507	8411-29	8411-29	8505-437	8505-406	8505-437	8411-30	8411-30	8505-452	8505-452
TRACE ELEMENTS										
ALUMINUM (AL)			4240			14900		4780		17710
ANTIMONY (SB)	<10	<10	16	<10	<10	<39	<10	<0.7	<10	<53
ARSENIC (AS)	127	2650	3170	750	84	974	208	238	525	765
BARIUM (BA)	130	255	108	170	250	167	270	115	260	298
BERYLLIUM (BE)			0.34			4		0.6		<5
CADMIUM (CD)	70	300	229	240	190	284	100	85	210	294
CHROMIUM (CR)	50	75	9.5	45	65	12	80	d	175	17
COBALT (CO)	16	33	12	25	20	36	20	11	19	33
COPPER (CU)	405	640	338	290	260	432	165	102	310	472
IRON (FE)	45000	33750	12000	27500	32750	24500	112500	10600	44500	32800
LEAD (PB)	1925	4650	3390	1450	1825	1865	1550	930	2200	3450
MANGANESE (MN)	950	2300	900	1450	2400	2130	1950	1210	3350	3970
MERCURY (HG)	3.2	7.9	174	6.0	10	7.6	3.4	1.9	13	28.7
NICKEL (NI)			6.5			14		7		20
SELENIUM (SE)			<0.12			<2.9		<0.12		<4
SILVER (AG)	14	40	4	13	12	10	10	4.2	15	24
THALLIUM (TL)			20			57		10		34.6
TIN (SN)			6.5			<26		4.1		<35
VANADIUM (V)	<100	<100	14	<100	<100	40	278	22	<100	54
ZINC (ZN)	2950	3075	1140	1825	2175	2890	1550	960	2450	4380

ALL QUANTITIES IN PARTS PER MILLION UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED

OUTPUT DATE: 12/18/85

APPENDIX 5-3

VEGETATION INVESTIGATION

0211108

VEGETABLE GARDEN SURVEY

General Information

Name ________________________________ Date __________

Address ____

Phone Number ______________

What is the age and sex of household members?

Age ___ ___ ___ ___ ___ ___ ___ ___

Sex ___ ___ ___ ___ ___ ___ ___ ___

Garden Information

1. How long have you had a garden at this address? ___ yrs

2. How long has the garden been in its current location in the yard? ___ yrs ___ don't know

3. Do you water your garden? ___ yes ___ no

   ____ city water
   ____ well water
   ____ irrigation ditch
   ____ other (please specify) ________________

5. Do you use any fertilizers? ____ yes ____ no
   If so, what kinds do you use?

   ____ inorganic (commercial fertilizer)
   ____ compost
   ____ super phosphate
   ____ manure
   cow ___ sheep ___ horse ___ chicken ___ other ___

   source of manure ________________________

6. Which kinds of soil conditioners, if any, do you use?

grass clippings	____	source	________________
leaves	____	source	________________
straw or hay	____	source	________________
ashes	____	source	________________
newspaper	____	source	________________
sewage sludge	____	source	________________
lime	____	source	________________
gypsum	____	source	________________
peat	____	source	________________
other (specify)	____	source	________________

7. Have you ever added topsoil to your garden? ____ yes ____ no
If so, what was the source?

____ commercial
____ other (please specify) ____________________

8. Do you use any pesticides or herbicides in your garden?
____ yes ____ no

If so, which ones do you use?

____
____

9. Please check crops that you usually grow:

lettuce	____	cabbage	____	radishes	____
onions	____	cauliflower	____	carrots	____
broccoli	____	turnips	____	peppers	____
squash	____	rutabaga	____	tomatoes	____
spinach	____	potatoes	____	celery	____
brussel sprouts	____	swiss chard	____	corn	____
peas	____	beans	____	other	____
herbs	____	strawberries	____		____

10. Do you freeze or can your produce? ____ yes ____ no

11. Do you sell or give away your produce? ____ yes ____ no

12. How do you prepare your produce for eating or cooking?

wash/rinse ____
wash/scrub ____
peel root vegetables ____
no cleaning ____

13. What percentage of your yearly food supply would you estimate comes from your garden?

1 - 5%	____	25 - 50%	____
5 - 10%	____	50 - 75%	____
10 - 25%	____	75 - 100%	____

Thank you for helping with the garden survey. Please return the completed questionnaire in the stamped, addressed envelope provided, to:

G. L. Rupp
MDI
P. O. Box 6446
Bozeman, Montana 59771

Appendix 5-3 (cont.). Results of Questionnaire Submitted to Owners of Gardens That Were Sampled.

Age and Sex of Residents:
22 males, avg. age = 36, age range = 1-75, under 6 yrs = 2
20 females, avg. age = 42, age range = 4-80, under 6 yrs = 1

Garden Age:
Average = 24 years, Range = 4-75 years

Water Source:
42% use city water, 58% use private well water

Fertilizer Use (number of gardeners which have used each type):

None = 1/12 or 8.3%	Commercial = 6/12 or 50%,
Compost = 4/12 or 33.3%	Super phosphate = 1/12 or 8.3%,
Manure = 12/12 or 100%	

Soil Conditioners (Number of gardeners which have used each type):

Grass = 9/12 or 75%	Leaves = 4/12 or 33.3%
Straw = 3/12 or 25%	Lime = 1/12 or 8.3%
Peat = 2/12 or 16.7%	Ashes = 2/12 or 16.7%
Wood Chips = 1/12 or 8.3%	Sand = 1/12 or 8.3%
Top Soil = 1/12 or 8.3%	

Pesticide Use:
10/12 or 83% use pesticides (mostly insecticides)

Crops Typically Grown in the Sampled Gardens:

Tomatoes = 12/12 or 100%	Cabbage = 6/12 or 50%
Potatoes = 11/12 or 92%	Cauliflower = 4/12 or 33.3%
Carrots = 10/12 or 83.3%	Turnips = 2/12 or 16.7%
Lettuce = 7/12 or 58.3%	Rutabaga = 3/12 or 25%
Swiss Chard = 2/12 or 16.7%	Beans = 8/12 or 66.7%
Beet Greens = 3/12 or 25%	Strawberries = 6/12 or 50%
Herbs = 4/12 or 33.3%	Radishes = 9/12 or 75%
Onions = 12/12 or 100%	Celery = 1/12 or 8.3%
Broccoli = 3/12 or 25%	Corn = 9/12 or 75%
Squash = 9/12 or 75%	Peppers = 7/12 or 58.3%
Spinach = 4/12 or 33.3%	Peas = 7/12 or 58.3%

Preparation for Cooking/Eating:
12/12 families wash and scrub all vegetables, 1/12 does not peel root crops.

Percent of Annual Food Supply Coming from Garden:
5/12 families or 42% get <10% of annual food supply
6/12 families or 50% get 10-25% of annual food supply
1/12 families or 8.3% get 50-75% of annual food supply

VEGETABLE GARDEN SURVEY

General Information

The ASARCO East Helena Plant has been committed to conduct all of the remaining field investigations scheduled under the Superfund program. At this time, it is necessary for ASARCO to collect data on the number of gardens located within two miles of the ASARCO plant. If you do not have a garden, answer no to the first question, refold the questionnaire and return it. If you know you are located further than 2 miles from the ASARCO plant, answer no to the second question, refold the questionnaire and return it. If you have a garden and are located within 2 miles of the ASARCO plant, please fill out the entire questionnaire. We appreciate your time and would be happy to answer any questions you might have.

Houshold Information

Name ____
Address ____
Age and sex of people who regularly eat from your garden (they can be houshold members, relatives, etc.)
age _____ _____ _____ _____ _____ _____ _____ _____
sex _____ _____ _____ _____ _____ _____ _____ _____

Garden Information

1. Do you have a garden? _____ yes _____ no
2. Are you located within 2 miles of the ASARCO plant?
   _____ yes _____ no _____ I don't know
3. How long have you had a garden at this address?
   _____ years _____ I don't know
4. How long has the garden been at its current location?
   _____ years _____ I don't know
5. How far is your garden from the nearest road or alley?
   _____ feet
6. Approximate size of your garden? ________________
7. What percentage of your yearly food supply would you estimate comes from your garden?
   _____ 1-5 _____ 10-25 _____ 50-75
   _____ 5-10 _____ 25-50 _____ 75-100

Micellaneous

8. Do you raise cattle or buy locally grown beef?
   _____ yes _____ no _____ I don't know
9. Do you grow grain or buy locally grown grain?
   _____ yes _____ no _____ I don't know

Appendix 5-3 (cont.). Results from Vegetable Survey sent to all residents in East Helena area. Summarized responses include only those people living within two miles of the ASARCO smelter. Post-enumeration survey results also included.

Garden Frequency (large survey)	Number	Percent	#Responses
Houses with vegetable gardens	259	63.3	409
Houses w/o vegetable gardens	150	36.7	
Garden Frequency (post-enumeration) survey			
Houses with vegetable gardens	77	51.3	150
Houses w/o vegetable gardens	73	48.7	

Possible range based on binomial function (from post-enumeration survey) 43-59%

------------------------- Garden Age -------------------------

years	number	percent	number	percent
</+2	36	13.9	25	10.4
3-4	33	12.7	29	12.0
5-6	20	7.7	15	6.2
7-9	31	12.0	36	14.9
9-10	29	11.2	25	10.4
11-15	34	13.1	34	14.1
16-20	22	8.5	19	7.9
21-30	16	6.2	17	7.1
31-40	10	3.9	12	5.0
41-50	10	3.9	12	5.0
>50	8	3.1	7	2.9
do not know	10	3.9	10	4.1

	Average	#Responses
Distance Between Garden and Nearest Street or Alley	63 feet	245
Approximate Size of Garden	1953 sq. ft.	246

Percentage of yearly food supply that comes from garden.

% of Total Annual Food Supply	Number of Households	Percent of Households	#Responses
1-5	94	36.7	256
5-10	64	25.0	
10-25	58	22.7	
25-50	24	9.4	
50-75	12	4.7	
75-100	4	1.5	

Number of People in Households w/ Gardens	Total	Male	Female	Not Indicated
	910	441	456	13

Age Distribution of Those w/ Gardens	<2yrs	2-6yrs	>6yrs	Avg. Age
	24	73	813	33.5

QUESTIONNAIRE FOR GRAIN PRODUCERS IN HELENA VALLEY

Please consider your full cropping cycle or a 3-year average when answering the following questions.
We understand that planting and production change from year to year. If you plan major changes in your operation in the near future, please explain at the end of the questionnaire.

1. What kinds of grain do you grow?
   winter wheat ___
   spring wheat ___
   malting barley ___
   feed barley ___
   other ___ (What kind? ____________)

2. What is your average yearly production in bushels?
   winter wheat ___
   spring wheat ___
   malting barley ___
   feed barley ___
   other ___

3. What kinds of fertlizer do you use? (N, P, K, S, organic supplements)

   ____

4. How are the fertilizers applied?
   injection ___
   spray ___
   broadcast ___
   other ___

5. Do you grind your own flour? yes ___ no ___

6. Do you know anyone in the area who grinds their own flour?
   yes ___ no ___
   name ____________________

7. Where do you market your grain? ____________________

8. Do you sell any grain to individual consumers? yes ___ no ___
   Name(s) of buyer(s) ______________________________

   ____

9. What type of irrigation do you use? (List as percentage of production.)
   flood ___
   sprinkle ___
   furrow ___
   other ___
   no irrigation ___

10. What type of cultural methods do you typically use? (List as percentage of production.)
   no till ___
   reduced till ___
   conventional till ___
   other ___ (describe briefly __________
   ____________________)

Appendix 5-3 (cont.) Results of the Grain Survey. There were twenty-four respondents. Every survey was not filled out completely so that there are fewer responses for some questions.

Kinds of grain grown (respondents (n) = 24):

Grain	Number of Growers	Average Production (bushels / Year)
Wheat	13	11743
Feed barley	19	3754
Malt barley	3	6250
Oats	7	6700

Kinds of fertilizer used (respondents (n) = 22)

Fertilizer	Number of Growers
nitrogen	20
phosphorus	16
potassium	12
sulfur	6
organic supplements	4
manure	1
none	2

Method of fertilizer application (n = 22)
Sixteen growers broadcast.
Six growers inject.

Method of irrigation (n =24)
Six growers flood, eight sprinkle, four flood and sprinkle.
Six growers do not irrigate.

Cultural methods (n = 24):
Two growers use reduced tillage, twenty growers use conventional tillage. Two growers use a combination of both methods (average land in reduced till = 25%).

Market outlets (n = 19):
All wheat growers sell grain to elevators. One grower also sells ground wheat to local individuals.

Growers (n = 24) who grind their own flour = 2
who know someone who does = 2 (same as above)
Additional phone contacts identified a total of five families who consume locally grown wheat.

Appendix 5-3. Trace element concentrations in garden vegetables.

Lab No.	Vegetable	Garden	Distance to road (ft)	Ag	As	Cd*	Cu	Hg	Mn	Pb	Sb	Se	Tl	Zn	Moisture (%)
								(wet weight, ug/g)							
CONTROL GARDEN															
7046	beet greens	18	25	0.084	0.036	0.062	0.880	0.022	14.300	0.176	0.044	0.011	r	5.170	89.0
7049	carrot	18	25	0.011	0.018	0.035	0.480	0.001	1.200	0.003	0.006	0.012	0.011	0.960	88.0
7047	lettuce	18	25	0.001	0.006	r	0.340	0.008	0.800	0.012	0.444	0.002	r	1.270	98.0
7048	potato	18	25	0.020	0.080	0.170	1.600	0.002	1.600	0.180	0.058	0.020	0.018	6.500	80.0
7045	tomato	18	25	0.383	0.018	r	2.050	0.001	1.300	r	0.028	0.010	0.009	2.350	90.0
TEST GARDENS															
7039	beet greens	1	75	0.260	0.474	2.760	3.840	0.008	10.500	4.740	0.277	0.028	r	52.800	88.0
7035	beet greens	17	30	0.221	0.344	2.475	2.860	0.024	9.570	2.123	0.267	0.034	0.010	38.500	89.0
6999	beet greens	2	25	0.138	0.144	1.710	2.385	0.004	4.815	1.422	0.124	0.035	0.081	40.500	91.0
7020	beet greens	14	25	r	0.360	1.140	1.260	0.018	16.200	0.572	0.048	0.040	r	8.640	88.0
6991	beet greens	6	20	r	0.102	0.840	1.560	0.011	8.640	0.460	0.065	0.012	0.053	16.800	88.0
7007	beet greens	7	15	r	0.099	0.660	1.375	0.004	11.715	1.419	0.070	0.043	0.010	6.930	89.0
7042	beet greens	10	25	0.038	0.043	0.225	1.485	0.005	7.515	0.432	0.041	0.009	0.008	4.815	91.0
7027	beet greens	9	200	0.038	0.030	0.200	1.050	0.003	14.500	0.098	0.005	0.010	0.044	3.750	90.0
7004	carrots	8	200	0.020	0.060	0.160	0.610	0.001	1.320	0.240	0.030	0.010	0.010	2.200	**89.0
7051	carrots	3	20	0.138	0.165	0.600	1.200	0.004	1.875	1.206	0.258	0.015	0.135	6.525	85.0
7000	carrots	2	25	0.060	0.195	0.250	1.200	0.008	1.000	r	0.086	0.010	0.045	5.300	90.0
7044	carrots	10	25	0.010	0.046	0.200	0.700	0.001	1.000	0.050	0.012	0.010	0.009	1.700	90.0
7040	carrots	1	75	0.009	0.049	0.180	0.495	0.001	0.855	0.351	0.015	0.009	0.008	3.330	91.0
7014	carrots	14	25	0.010	0.135	0.076	0.500	0.001	0.750	0.268	0.039	0.024	0.044	1.150	90.0
7031	carrots	9	200	0.011	0.037	0.073	0.660	0.001	1.200	0.084	0.006	0.012	0.053	2.040	88.0
7057	carrots	16	300	0.198	0.082	0.049	0.650	0.002	1.105	0.156	0.055	0.003	0.011	2.080	87.0
6983	carrots	6	20	0.010	0.150	r	0.750	0.002	1.200	0.351	0.017	0.010	0.044	3.000	90.0
7008	carrots	7	15	r	0.070	r	0.600	0.001	1.250	0.258	0.024	0.010	0.009	1.900	90.0
7022	chard	14	25	0.060	0.840	2.100	1.380	0.020	37.800	0.767	0.035	0.060	0.011	19.200	88.0
7023	chard	9	200	0.009	0.047	0.135	1.125	0.011	10.350	0.307	0.013	0.009	r	3.780	91.0

r = result rejected during data validation (Roy F. Weston, Inc. 1988)
Cd* = Within each sample group, the samples are listed in order of decreasing Cd
** = Estimated value = average moisture content of all the other carrot samples

Appendix 5-3 (continued)

Lab No.	Vegetable	Garden	Distance to road (ft)	Ag	As	Cd*	Cu	Hg	Mn	Pb	Sb	Se	Tl	Zn	Moisture (%)
								(wet weight, ug/g)							
7037	lettuce	17	30	0.075	0.470	1.820	2.485	0.017	2.660	2.184	0.179	0.007	0.006	11.550	93.0
7038	lettuce	1	75	0.140	0.645	1.120	1.920	0.020	5.200	4.200	0.205	0.008	0.007	5.480	92.0
6995	lettuce	13	200	r	0.426	0.800	1.000	0.003	9.650	r	0.032	0.010	0.044	2.600	90.0
7036	lettuce	17	30	0.116	0.537	0.540	2.820	0.018	3.060	2.280	0.182	0.006	0.005	5.400	94.0
7053	lettuce	16	300	0.163	0.525	0.525	2.310	0.020	7.630	12.250	0.341	0.007	0.006	19.250	93.0
7025	lettuce	9	200	0.009	0.076	0.280	0.770	0.015	7.000	0.437	0.015	0.014	0.031	4.375	93.0
7018	lettuce	14	25	r	0.119	0.270	1.590	0.008	2.730	0.292	0.034	0.020	0.005	3.090	94.0
6998	lettuce	12	0	0.009	0.168	0.240	0.640	0.005	2.560	1.128	0.031	0.008	0.035	2.400	92.0
6979	lettuce	6	20	r	0.102	0.200	0.340	0.004	1.480	0.538	0.025	0.002	r	1.790	98.0
7005	potatoes	8	200	0.100	0.500	0.440	5.500	0.030	10.500	1.740	0.240	0.100	0.090	23.000	0.0
7001	potatoes	2	25	r	0.162	0.270	2.790	0.007	1.350	1.454	0.133	0.018	0.016	6.750	82.0
6997	potatoes	11	30	0.020	0.090	0.200	1.400	0.012	1.100	0.410	0.010	0.020	0.018	4.700	80.0
6993	potatoes	13	200	0.019	0.066	0.184	1.805	0.006	1.995	0.456	0.009	0.019	0.084	3.135	81.0
7016	potatoes	14	25	0.019	0.105	0.180	1.805	0.008	1.235	0.445	0.070	0.046	0.084	5.415	81.0
7052	potatoes	3	20	0.021	0.092	0.129	1.495	0.018	1.380	0.041	0.011	0.023	0.021	3.795	77.0
7033	potatoes	9	0	0.019	0.103	0.114	1.235	0.008	1.710	0.152	0.082	0.019	0.017	3.515	81.0
7009	potatoes	7	15	r	0.080	0.106	1.760	0.005	1.200	0.205	0.024	0.016	0.070	4.160	84.0
6987	potatoes	6	20	0.059	0.068	0.104	2.125	0.005	1.445	0.163	0.036	0.017	0.075	4.335	83.0
7059	potatoes	16	300	0.032	0.370	r	3.960	0.004	2.145	0.330	0.132	0.033	0.029	11.055	67.0
6981	parsley	6	20	r	0.120	0.240	1.560	0.017	6.720	1.488	0.044	0.012	0.053	10.500	88.0
6985	tomatoes	6	20	r	0.030	0.100	1.150	0.005	0.500	0.229	0.130	0.005	0.022	1.250	95.0
7041	tomatoes	1	75	0.002	0.010	0.060	0.520	0.001	0.440	0.040	0.007	0.004	0.004	1.160	96.0
6994	tomatoes	13	200	0.013	0.011	0.060	0.735	0.002	0.825	0.050	0.009	0.003	0.003	1.440	97.0
7050	tomatoes	3	20	0.009	0.015	0.058	0.640	0.003	0.680	0.002	0.004	0.008	0.007	1.720	92.0
6996	tomatoes	11	30	r	0.027	0.045	0.690	0.001	0.660	0.077	0.055	0.006	0.005	1.650	94.0
7012	tomatoes	14	25	r	0.018	0.028	0.450	0.001	0.525	0.129	0.024	0.005	0.004	0.850	95.0
7055	tomatoes	16	300	0.009	0.013	0.026	0.637	0.004	0.603	0.002	0.010	0.006	0.006	1.039	93.3
7006	tomatoes	8	200	r	0.012	0.023	0.510	0.001	0.600	0.058	0.017	0.006	0.005	1.260	94.0
7029	tomatoes	9	200	0.009	0.004	0.017	0.700	0.001	0.595	0.018	0.025	0.007	0.031	1.120	93.0
7043	tomatoes	10	25	0.007	0.009	r	1.000	0.006	0.650	0.013	0.003	0.005	0.004	1.975	95.0

r = result rejected during data validation (Roy F. Weston, Inc. 1988)
Cd*= Within each vegetable group the samples are listed in order of decreasing Cd

Garden Vegetable

Sample Tracking Information

Record#	LAB_NO	TAG	COC_NO	TYPE	PLANT	STATION	COLLDATE	RDDISTANCE
1	6979	52252	4190	n	l	v6	08/26/87	20
2	6980	52253	4190	d	l	v6	08/26/87	20
3	6981	52256	4190	n	ps	v6	08/26/87	20
4	6982	52257	4190	d	ps	v6	08/26/87	20
5	6983	52258	4190	n	c	v6	08/26/87	20
6	6984	52259	4190	d	c	v6	08/26/87	20
7	6985	52260	4190	n	t	v6	08/26/87	20
8	6986	52261	4190	d	t	v6	08/26/87	20
9	6987	52262	4190	n	p	v6	08/26/87	20
10	6988	52263	4190	d	p	v6	08/26/87	20
11	6989	52264	4190	d	bg	v6	08/26/87	20
12	6990	52265	4190	d	bg	v6	08/26/87	20
13	6991	52250	4189	n	bg	v6	08/26/87	20
14	6992	52251	4189	d	bg	v6	08/26/87	20
15	6993	52266	4190	n	p	v13	08/26/87	200
16	6994	52267	4190	n	t	v13	08/26/87	200
17	6995	52269	4190	n	l	v13	08/26/87	200
18	6996	52206	4188	n	t	v11	08/26/87	30
19	6997	52224	4188	n	p	v11	08/26/87	30
20	6998	52226	4188	n	l	v12	08/26/87	0
21	6999	52228	4188	n	bg	v2	08/26/87	25
22	7000	52230	4188	n	c	v2	08/26/87	25
23	7001	52232	4188	n	p	v2	08/26/87	25
24	7002	52234	4188	ccb		v2	08/26/87	25
25	7003	52235	4188	bb		v2	08/26/87	25
26	7004	52236	4188	n	c	v8	08/26/87	200
27	7005	52238	4188	n	p	v8	08/26/87	200
28	7006	52239	4188	n	t	v8	08/26/87	200
29	7007	52241	4188	n	bg	v7	08/26/87	15
30	7008	52243	4188	n	c	v7	08/26/87	15
31	7009	52244	4188	n	p	v7	08/26/87	15
32	7010	52246	4188	ccb		v7	08/26/87	15
33	7011	52275	4192	d	ch	v14	08/26/87	25
34	7012	52276	4192	n	t	v14	08/26/87	25
35	7013	52277	4192	d	t	v14	08/26/87	25
36	7014	52278	4192	n	c	v14	08/26/87	25
37	7015	52279	4192	d	c	v14	08/26/87	25
38	7016	52280	4192	n	p	v14	08/26/87	25
39	7017	52281	4192	d	p	v14	08/26/87	25
40	7018	52270	4191	n	l	v14	08/26/87	25
41	7019	52271	4191	d	l	v14	08/26/87	25
42	7020	52272	4191	n	bg	v14	08/26/87	25
43	7021	52273	4191	d	bg	v14	08/26/87	25
44	7022	52274	4191	n	ch	v14	08/26/87	25
45	7023	52282	4192	n	ch	v9	08/27/87	200

Garden Vegetable
Sample Tracking Information (Cont.)

Record#	LAB_NO	TAG	COC_NO	TYPE	PLANT	STATION	COLLDATE	RDDISTANCE
46	7024	52283	4192	d	ch	v9	08/27/87	200
47	7025	52284	4192	n	l	v9	08/27/88	200
48	7026	52285	4192	d	l	v9	08/27/87	200
49	7027	52286	4192	n	bg	v9	08/27/87	200
50	7028	52287	4192	d	bg	v9	08/27/87	200
51	7029	52288	4192	n	t	v9	08/27/87	200
52	7030	52289	4192	d	t	v9	08/27/87	200
53	7031	52290	4193	n	c	v9	08/27/87	200
54	7032	52291	4193	d	c	v9	08/27/87	200
55	7033	52292	4193	n	p	v9	08/27/87	0
56	7034	52293	4193	d	p	v9	08/27/87	200
57	7035	52303	4191	n	bg	v17	08/27/87	30
58	7036	52304	4191	n	l	v17	08/27/87	30
59	7037	52305	4191	n	l	v17	08/27/87	30
60	7038	52306	4191	n	l	v1	08/27/87	75
61	7039	52307	4191	n	bg	v1	08/27/87	75
62	7040	52308	4191	n	c	v1	08/27/87	75
63	7041	52309	4191	n	t	v1	08/27/87	75
64	7042	52310	4191	n	bg	v10	08/27/87	25
65	7043	52311	4191	n	t	v10	08/27/87	25
66	7044	52312	4189	n	c	v10	08/27/87	25
67	7045	52313	4191	n	t	v18	08/27/87	25
68	7046	52316	4189	n	bg	v18	08/27/87	25
69	7047	52317	4189	n	l	v18	08/27/87	25
70	7048	52314	4194	n	p	v18	08/27/87	25
71	7049	52315	4194	n	c	v18	08/27/87	25
72	7050	52247	4189	n	t	v3	08/26/87	20
73	7051	52248	4189	n	c	v3	08/26/87	20
74	7052	52249	4189	n	p	v3	08/26/87	20
75	7053	52294	4193	n	l	v16	08/27/87	300
76	7054	52295	4193	d	l	v16	08/27/87	300
77	7055	52296	4193	n	t	v16	08/27/87	300
78	7056	52297	4193	d	t	v16	08/27/87	300
79	7057	52298	4193	n	c	v16	08/27/87	300
80	7058	52299	4193	d	c	v16	08/27/87	300
81	7059	52300	4193	n	p	v16	08/27/87	300
82	7060	52301	4193	d	p	v16	08/27/87	300
83	7061	52302	4193	ccb		v16	08/27/87	300
84	7062	52318	4189	std		v0	08/27/87	0
85	7063	52319	4189	std		v0	08/27/87	0
86	7064	52320	4189	std		v0	08/27/87	0
87	7065	52321	4189	std		v0	08/27/87	0

Appendix 5-3. Element concentrations (ug/g dry weight) in
(cont.) Helena Valley grainheads (1984 & 1987 data).

STATION	AS	CD	CU	HG	PB	ZN
12	0.280	0.130	4.50	0.025	0.17	24.00
45	0.280	0.120	5.10	0.025	0.27	36.00
34	0.170	0.500	7.00	0.025	0.27	49.00
30	0.350	0.250	5.00	0.025	0.25	34.00
24	0.250	0.250	4.00	0.025	0.27	28.00
27	0.090	0.250	6.40	0.025	1.30	43.00
29	0.240	0.250	6.60	0.025	0.20	50.00
35	0.210	0.380	4.90	0.025	0.19	40.00
39	0.140	0.250	5.90	0.025	0.27	28.00
44	0.200	0.250	5.00	0.025	0.28	21.00
6	0.070	0.080	4.80	0.025	1.30	28.00
21	0.120	1.100	5.00	0.025	0.21	41.00
28	0.240	0.880	5.10	0.025	0.35	34.00
11	0.290	0.250	6.60	0.025	0.36	38.00
32	0.190	0.500	4.30	0.025	0.24	25.00
31	0.210	0.250	5.50	0.025	0.41	40.00
33	0.610	0.630	5.30	0.025	0.34	40.00
41	0.310	0.250	5.40	0.025	0.35	41.00
46	0.310	0.380	6.00	0.025	0.37	39.00
40	0.300	0.750	6.90	0.025	1.00	49.00
47	0.230	0.250	4.90	0.025	0.39	34.00
26	0.130	0.120	4.60	0.025	0.29	24.00
23	0.110	0.380	5.10	0.025	0.18	24.00
48	0.150	0.130	5.90	0.025	0.27	29.00
25	0.100	0.880	3.60	0.025	0.22	31.00
13	0.160	0.380	4.50	0.025	0.30	29.00
36	0.200	0.250	3.60	0.025	0.43	30.00
38	0.150	0.380	5.60	0.025	0.37	24.00
37	0.210	1.900	5.10	0.025	0.29	60.00
43	0.240	0.750	4.30	0.025	0.24	40.00
49	0.120	1.000	5.80	0.025	0.31	31.00
42	0.370	0.380	6.10	0.025	0.48	31.00
5	0.390	0.500	6.50	0.025	0.51	54.00
3	0.250	0.250	5.60	0.025	0.22	55.00
4	0.290	0.050	4.60	0.025	0.42	41.00
20	0.170	0.060	3.60	0.025	0.22	45.00
18	0.110	0.250	4.30	0.025	0.28	54.00
7	0.170	0.380	3.50	0.025	0.27	28.00
8	0.230	0.500	4.30	0.025	0.26	29.00
2	0.100	0.025	5.80	0.025	0.19	46.00
22	0.240	0.250	4.50	0.025	0.40	36.00
50	0.340	2.100	5.30	0.025	1.00	53.00

(continued next page)

Appendix 5-3. Element concentrations (ug/g dry weight) in
(cont.) Helena Valley grainheads (1984 & 1987 data)
(continued).

STATION*	AS	CD	CU	HG	PB	ZN
D-016	0.050	0.250	4.00	0.050	0.70	37.00
D-020	0.050	0.250	3.00	0.040	1.00	25.00
D-001	0.050	0.250	4.00	0.001	0.80	62.00
D-017	0.050	0.250	3.00	0.030	2.20	35.00
D-023	0.050	0.250	4.00	0.030	1.00	40.00
D-021	0.050	1.000	3.00	0.110	1.50	44.00
D-022	0.050	0.250	3.00	0.040	1.20	31.00
D-014	0.050	0.250	5.00	0.040	1.10	39.00
D-013	0.050	0.250	4.00	0.001	0.70	26.00
D-015	0.050	1.000	4.00	0.040	1.10	35.00
D-002	0.050	1.400	3.00	0.040	0.05	29.00
D-007	0.050	0.250	2.00	0.020	0.05	26.00
D-004	0.050	0.250	4.00	0.020	0.05	36.00
D-006	0.050	0.250	3.00	0.020	0.05	39.00

* D prefix indicates 1984 data.

ASARCO Grainhead Sample Tracking Information

Record#	Lab_No	Tag	COC_No	Type	Station	Colldate
1	11524	51651	8-04210	N	12	08/10/87
2	11525	51654	8-04210	N	45	08/10/87
3	11526	51699	8-04210	N	34	08/10/87
4	11527	52210	8-04210	N	30	08/10/87
5	11528	51698	8-04210	N	24	08/10/87
6	11529	51696	8-04210	CCB	24	08/10/87
7	11530	51695	8-04210	BB	24	08/10/87
8	11531	51694	8-04210	N	27	08/10/87
9	11532	51693	8-04210	N	29	08/10/87
10	11533	50982	8-04210	BFS	100	12/15/87
11	11534	50985	8-04210	BFS	100	12/15/87
12	11535	50984	8-04210	BFS	100	12/15/87
13	11536	50983	8-04210	BFS	100	12/15/87
14	11537	51692	8-04210	N	35	08/11/87
15	11538	51690	8-04210	N	39	08/11/87
16	11539	52208	8-07421	N	44	08/11/87
17	11540	51688	8-07421	N	6	08/11/87
18	11541	51683	8-07421	N	21	08/11/87
19	11542	51685	8-07421	N	28	08/11/87
20	11543	51684	8-07421	N	11	08/11/87
21	11544	51655	8-07421	N	32	08/11/87
22	11545	51682	8-07421	N	31	08/11/87
23	11546	51656	8-07421	N	33	08/11/87
24	11547	51660	8-07421	D	41	08/11/87
25	11548	51659	8-07421	N	41	08/11/87
26	11549	51661	8-07421	N	46	08/11/87
27	11550	51663	8-07421	N	40	08/11/87
28	11551	51691	8-07421	N	49	08/12/87
29	11552	52202	8-07421	N	26	08/12/87
30	11553	52203	8-07421	N	23	08/12/87
31	11554	52204	8-07422	N	48	08/12/87
32	11555	52201	8-07422	D	26	08/12/87
33	11556	51686	8-07422	BB	26	08/12/87
34	11557	51687	8-07422	CCB	26	08/12/87
35	11558	52205	8-07422	N	14	08/18/87
36	11559	51666	8-07422	N	15	08/18/87
37	11560	51667	8-07422	N	16	08/18/87
38	11561	51670	8-07422	N	25	08/18/87
39	11562	51668	8-07422	CCB	25	08/18/87
40	11563	51669	8-07422	BB	25	08/18/87
41	11564	51671	8-07422	N	13	08/19/87
42	11565	51672	8-07422	N	36	08/19/87
43	11566	51673	8-07422	N	38	08/19/87
44	11567	51674	8-07422	N	37	08/19/87
45	11568	51675	8-07422	N	43	08/19/87

ASARCO Grainhead Sample Tracking Information (cont'd)

Record#	Lab_No	Tag	COC_No	Type	Station	Colldate
46	11569	51676	8-07423	N	49	08/19/87
47	11570	51677	8-07423	N	42	08/19/87
48	11571	51679	8-07423	N	5	08/19/87
49	11572	51680	8-07423	D	5	08/19/87
50	11573	51678	8-07423	CCB	5	08/19/87
51	11574	52212	8-07423	N	3	08/20/87
52	11575	52213	8-07423	N	4	08/20/87
53	11576	52214	8-07423	N	20	08/20/87
54	11577	52215	8-07423	N	18	08/20/87
55	11578	52216	8-07423	N	7	08/20/87
56	11579	52217	8-07423	N	8	08/20/87
57	11580	52218	8-07423	N	2	08/21/87
58	11581	52219	8-07423	N	22	08/21/87
59	11582	52221	8-07423	N	50	08/21/87
60	11583	52222	8-07423	D	50	08/21/87
61	11584	52220	8-07424	CCB	50	08/21/87

APPENDIX 5-4

CATTLE INVESTIGATION

QUESTIONNAIRE FOR BEEF PRODUCERS IN HELENA VALLEY

We realize that your cattle management and sales may change from year to year. Fill this questionnaire out to describe your operation over the last three years. Then, if you anticipate major changes in your operation in the next few years, or if you would like to make other comments about how your operation runs, please do so in the space at the end of the questionnaire.

---

1. Do you own __ or manage __ (check one) beef cattle which are raised in the Helena Valley? yes __ no __

2. How many cattle do you own? ____________

3. What do you do with the cattle that you own/manage? (Answer yes or no for all of the options listed below.)

			Number of animals (approx.)
(a) Sell to Livestock Market Name of Market ____________	yes __	no __	______
(b) Sell cattle to slaughterhouse/meat processor. Name(s) of slaughterhouse(s): ____________	yes __	no __	______
(c) Sell cattle to stores Name(s) of store(s) ____________ ____________	yes __	no __	______
(d) Sell cattle to restaurants Name(s) of restaurant(s) ____________ ____________	yes__	no __	______

(e) Sell cattle to individuals yes___ no ___ _________

Name(s) of individuals ______________

____

(f) Keep cattle for your own consumption yes___ no ___ _________

Background information

4. Approximately how many months per year do the cattle graze on pasture? ___

5. What type of pasture do the cattle graze on? alfalfa ___ grass ___ mixed ___

6. Is the pasture irrigated? yes ___ no ___ both irrigated and dryland ___

Do the cattle graze only on your homeplace? yes ___ no ___

8. If you answered no to question 7., where else do the cattle graze?

____

9. What do the cattle feed on other than pasture? alfalfa hay___ wheat___ grass hay___ oats___ barley___ corn___ other ___

10. Where do you get the winter feed? grown on home place___ purchased from local growers ___ purchased from non-local suppliers ___

11. List health problems (if any) that your herd has had in the last three years:

____

____

COMMENTS: ______________________________

____

____

QUESTIONNAIRE FOR CONSUMERS OF BEEF PRODUCED IN HELENA VALLEY

1. Do you purchase beef from local ranchers? yes ___ no ___

   Name(s) of rancher(s) ______________________________

   ____

   ____

2. Do you purchase beef from local meat processors? yes ___ no ___

   Name(s) of retailer(s) ______________________________

   ____

   ____

3. Do you and/or your family eat beef that is raised on your home place? yes ___ no ___

4. Approximately how much locally-grown beef does your household consume per week? ________ (# of lbs.)

5. How many people are in your household? ________

Appendix 5.4 (cont'd). Responses to beef questionnaire

Management Information:

Number of responses = 117
Number of herd owners in study area = 40
Number of cattle in study area = 2940
Average herd size = 74
Distribution of herd sizes:

Herd size range	# Ranchers
1-10	9
11-20	5
21-30	6
31-40	4
41-50	3
51-100	6
>100	8

Marketing practices:
- 31 sell to livestock markets
- 5 sell to local processors
- 9 sell to local individuals
- 1 sells directly to a feedlot
- 0 sell directly to stores, restaurants

Average time on pasture: 8 months
Distribution of grazing duration:

Months of grazing	#Herds
1-2	2
3-4	0
5-6	15
7-8	11
9-10	3
11-12	9

Grazing type:
- 1 alfalfa pasture
- 16 grass pasture
- 18 mixed alfalfa/grass pasture

Grazing location:
- 26 herds all on home pasture
- 9 graze outside study area part-time

Watering of pasture:
- 16 irrigated
- 15 mixed irrigated and dryland

Non-pasture feed:

7 alfalfa hay	4 supplement w/oats
3 grass hay	1 with wheat
18 alfalfa + grass	1 with corn
6 alfalfa + barley	

Consumption Information:

Local use:
- 53 households consume their own beef
- 23 households purchase from local ranchers or meat processors
- 3.9 lbs = average consumption per person per week. (67 responses, average of four individuals per household)

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Appendix 5.4 (cont'd). Background information on individual animals, beef tissue study.

Animal	Sex	Age (yrs)	Rancher's Eartag #	EPA Eartag #	Breed	Weight (lbs,est.)	Pregnant?	Feed, Fall 1987	Feed, Summer 1987	Summer Feed, Pre-1987	Feed, Winter 1987	Water Source	DVM comment during sampling
HERD 1 (control)													
R-1	C	>10	B96		Hereford	1100	N	Home ranch	Home ranch	Mountain	Alfalfa/grass	ranch	no bottom teeth
R-2	C	>10	348		"	900	N	pasture	pasture	pasture	(home-grown)	creek	1" cyst on kidney
R-3	C	>10	B29		"	750	N	"	"	"	"	"	no bottom teeth,cyst
R-4	C	>10	579		"	900	N	"	"	"	"	"	
R-5	C	>10	B60		"	900	N	"	"	"	"	"	
R-6	C	>10	732		"	900	N	"	"	"	"	"	
HERD 2 (test)													
B-1	B	4	208S		Simmental	1800	N	Home ranch	Home ranch	Mountain	Alfalfa/grass	Prickly Pear	adhesions in chest cavity
B-2	C	9	20K		"	1200	N	pasture	pasture	pasture	(home-grown)	Creek	(from pneumonia)
B-3	C	5	41P		"	900	Y	"	"	"	"	"	
B-4	C	12	593G		"	1600	N	"	"	"	"	"	
B-5	H	2	62T		"	1000	Y	"	"	"	"	"	
B-6	H	2	682V		"	850	Y	"	"	"	"	"	
HERD 3 (test)													
J-1	C	4.5	none	81AKM1268	Hereford	1100	Y	Home ranch	Home ranch	Home ranch	Alfalfa/grass	ranch	4" abcess on kidney
J-2	C	2.5	none		"	-	Y	pasture +	pasture	pasture	(purchased in	spring	
J-3	C	4.5	none		"	-	Y	§10 lbs hay	"	"	Helena Valley)		
J-4	C	2.5	none	81AKM1270	cross	-	Y	per day/cow	"	"	"		
J-5	C	2.5	none		cross	850	Y	+ small am't	"	"	"		
J-6	C	3.5	none		cross	-	Y	barley; all	"	"	"		
								home-grown					

APPENDIX 5-5

ASSESSMENT OF POTENTIAL EXPOSURE PATHWAYS OF METAL CONTAMINANTS FROM MIGRATORY WATERFOWL AT UPPER LAKE TO HUMAN RECEPTORS

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ASSESSMENT OF POTENTIAL EXPOSURE PATHWAYS OF METAL CONTAMINANTS FROM MIGRATORY WATERFOWL AT UPPER LAKE TO HUMAN RECEPTORS

For:

ASARCO, Inc.
P.O. Box G
East Helena, MT 59635

By:

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and

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November, 1988

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ASSESSMENT OF POTENTIAL EXPOSURE PATHWAYS OF METALS CONTAMINANTS FROM MIGRATORY WATERFOWL AT UPPER LAKE TO HUMAN RECEPTORS

1.0 INTRODUCTION

An assessment of potential exposure pathways of metals contaminants to humans from Upper Lake waterfowl was conducted in accordance with the Comprehensive Remedial Investigation/Feasibility Study (RI/FS) work plan. This plan was submitted by ASARCO to the Environmental Protection Agency (EPA) in September, 1987. As described in the RI/FS work plan, this assessment consisted of:

1) An evaluation of existing Upper Lake bottom sediment and surface water quality data to determine adequacy and representativeness of site conditions. This step also included a comparison with sediment and water quality data collected during the Warm Springs Ponds contaminants assessment;

2) A literature search to determine if a correlation exists between metals concentration in migratory waterfowl and metals concentration in surface waters and bottom sediment; and

3) If a correlation existed in the literature for metals concentration between sediment, water and waterfowl, a comparison against ARARs and any other relevant human health

and environmental guidelines was to be conducted. As discussed in more detail below, this comparison was not possible. Although the literature search provided insight into the potential exposure to humans of metals contaminants from waterfowl, a correlation between metals concentrations in bottom sediment and/or water quality was not found.

Upper Lake is a pond and associated marsh located southeast of the ASARCO smelter complex (Figure 1). Upper Lake receives flow from a diversion on Prickly Pear Creek located about 1/2-mile south of the plant. Upper Lake water is used in the smelter operations as make-up water and to supply irrigation water to Wilson Ditch. Flow into the ditch is controlled by a headgate at the lake.

Upper Lake is part of property owned by ASARCO and there is no public access to the pond. Its shorelines are vegetated with a mix of mesic species and the pond supports a variety of emergent and submergent plants. A small number of waterfowl nest in or near the pond and it receives variable use during migration.

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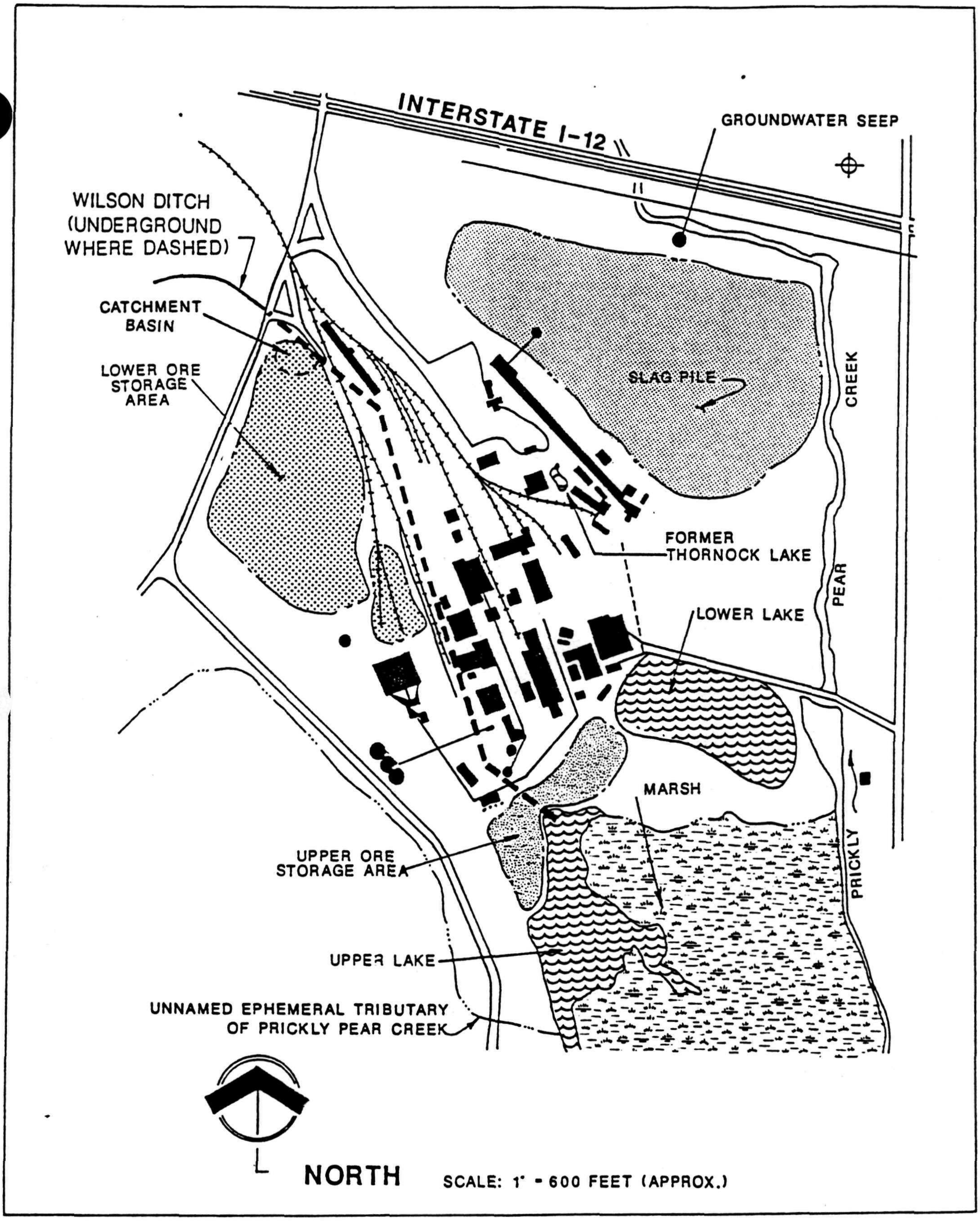


Figure 1 Location Map of Asarco East Helena Plant Area Showing Upper Lake

2.0 BOTTOM SEDIMENT AND SURFACE WATER QUALITY

2.1 UPPER LAKE BOTTOM SEDIMENT AND SURFACE WATER QUALITY

Bottom sediment and surface water quality from Upper Lake are in Appendix 1. Bottom sediments from random locations in Upper Lake were collected from a small boat. Sediment cores were obtained with a BM-53 piston type core sampler. Six cores collected over two sampling episodes (11-4-84 and 6-6-85) were analyzed by the ASARCO Salt Lake laboratory and an EPA CLP laboratory. These samples were collected in accordance with the Phase I Water Resources Monitoring (WRM) work plan; sampling frequency and locations met the requirements of the work plan.

Analyses revealed that Upper Lake bottom sediments have elevated concentrations of arsenic and metals. Possible causes of elevated metals concentrations in Upper Lake bottom sediment are: fallout of airborne particlates from smelter emissions; overland runoff of sediment containing high metals concentrations into Upper Lake; or deposition of metals-bearing sediment derived from old upstream mining disturbances and tailings in the Prickly Pear Creek drainage.

Upper Lake water samples were collected at random locations from a small boat. Samples were collected during four sample episodes (11-7-84, 4-4-85, 6-6-85 and 8-6-85) and were analyzed by the ASARCO Salt Lake laboratory and by an EPA CLP laboratory. Two additional Upper

Lake water samples were collected at site WD-1, at the headgate to Wilson Ditch. All water samples were collected in accordance with the Phase I WRM work plan and sampling frequency and locations met the requirements of the work plan.

Results of Upper Lake water analyses indicated that water quality is essentially the same as Prickly Pear Creek upstream of the smelter (Phase I WRM report, Hydrometrics, 1985). Generally, Upper Lake water is a hard, alkaline, calcium-bicarbonate type with moderate concentrations of total dissolved solids (TDS) and low to moderate concentrations of arsenic and metals (see Appendix 1).

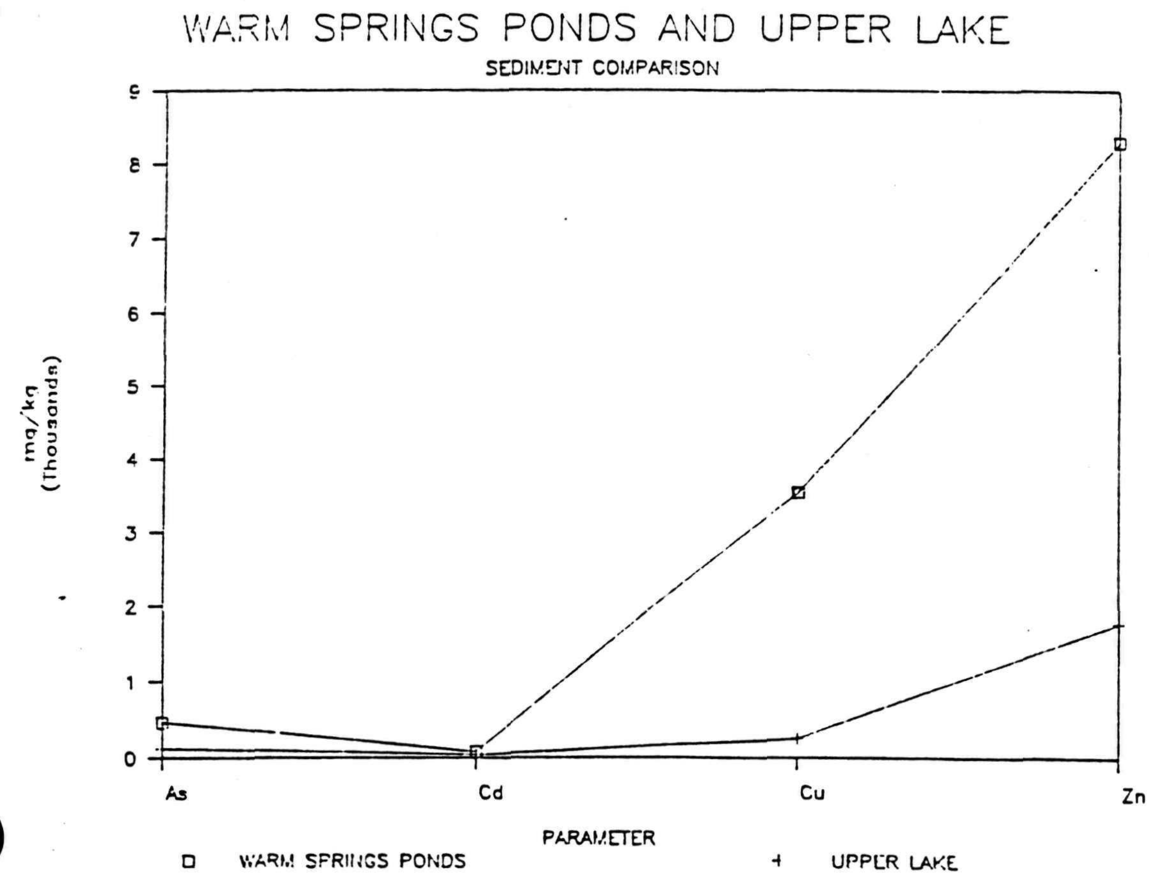
The Upper Lake sampling program was originally designed to meet the objectives of the Phase I WRM invesitagation, and the potential requirements of a waterfowl investigation were not considered during bottom sediment and surface water collection. However, these data represent site conditions and provide required information about Upper Lake bottom sediment and water quality.

2.2 BOTTOM SEDIMENT DATA COLLECTED FROM THE WARMS SPRINGS PONDS

Preliminary sediment data for the Warm Springs Ponds on Silver Bow Creek are in Table 1. The elements analyzed from the Warm Springs Ponds are arsenic, cadmium, copper and zinc. No data for lead or any other elements are available. These data are preliminary but do provide some insight into a comparison of sediment data with the

Table 1 COMPARISON OF As, Cd, Cu, AND Zn IN SEDIMENTS AT WARM SPRINGS PONDS AND ASARCO UPPER LAKE SEDIMENTS

POND #	ELEMENT	WARM SPRINGS PONDS AVG. CONC. OF UPPER 5 ft. OF SEDIMENT IN mg/kg		UPPER LAKE AVG. CONC. OF UPPER 1 ft. OF SEDIMENT IN mg/kg
1	As	376		
	Cd	2.5		
	Cu	700		
	Zn	600		
2	As	645		
	Cd	25		
	Cu	3600		
	Zn	3900		
3	As	364		
	Cd	204		
	Cu	6300		
	Zn	20400		
POND AVG.	As	461	As	121.17
	Cd	77.1	Cd	38.17
	Cu	3533	Cu	255.3
	Zn	8300	Zn	1768.5



potential accumulation of metals in waterfowl, since waterfowl at the Warm Springs Ponds were also sampled. The results of the waterfowl sampling program are discussed in detail in the literature review section (3.0) of this document.

A comparison of the Warm Springs Ponds sediment data with the Upper Lake sediment data is also given in Table 1. This comparison shows:

1) the average metals concentrations between sediments from Warm Springs Ponds 1, 2 and 3 vary significantly between the ponds.

2) The average concentrations of arsenic, cadmium, copper and zinc for all the Warm Springs Ponds sediments is significantly higher than the average concentrations of these same parameters for Upper Lake sediments.

The significance of the Warms Springs Ponds and Upper Lake sediment comparisons is discussed in section 4.0 below.

3.0 LITERATURE REVIEW

3.1 METHODOLOGY

The literature review was conducted by examining journals, books and reprints on file in WESTECH's and Hydrometrics' in-house libraries; by visiting the libraries at the University of Montana (Missoula) and Montana State University (Bozeman), as well as the Montana state library in Helena; and through computerized literature searches. These searches were through the Fish and Wildlife Reference Service (which includes many citations from government agencies and university research), the DIALOG Information Retrieval Service of Biosis Previews (citations from Biological Abstracts) and EMBASE (which searches biomedical literature), and the U.S. Department of Commerce National Technical Information Service (NTIS). Additional publications were requested from the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service.

Several hundred titles were examined. The most relevant were selected for more detailed review, and these were further reduced to the citations included in this report. Whenever possible, sources were used that summarized or annotated previously published literature.

3.2 FACTORS INFLUENCING THE EFFECTS OF HEAVY METALS ON WATERFOWL AND HUMAN RECEPTORS

The literature review revealed that it is very difficult to predict whether or not heavy metals, when known to be present in an aquatic ecosystem, will affect waterfowl using that ecosystem. Some of the factors influencing these effects are:

1) Biotic: differences between species of waterfowl; differences between sexes and age classes within a particular species; differences between individuals of the same species, sex and age; differences in food habits between species; changes in food habits of a particular species, either seasonally or annnually, based on food availability at the site and/or at other feeding sites; occurrence of other avian diseases that may exacerbate the effects of metals; the season of use of a contaminated site (e.g. breeding vs. wintering areas); exposure time (i.e., length of use of a contaminated site); diversity and abundance of plants; and microbial activity in sediments.

2) Abiotic: water depth, temperature, pH, hardness, salinity, oxygen content and amount and types of organic compounds; the presence of other metals; the amount of suspended sediment; the form of the metal present; the size of the metal particles present; and climatic factors that affect the use of the site by waterfowl.

(Sources: Behan et al., 1979; Custer and Mulhern, 1983; DiGuilio and Scanlon, date uncertain; D'Itri, 1971; Eisler, 1985, 1987, 1988a, 1988b; Fimreite, 1974; Forstner and Wittman, 1983; Hesse et al., 1975; Hill et al., 1975; Hoffman and Curnow, 1979; Kadlec, 1987; Koranda et al., 1979; Oscarson et al., 1980; Pearce et al., 1976; Stout and Cornwell, 1976; Tolin, 1975; Van Hassel et al., 1980; Vermeer, 1971; Vermeer and Armstrong, 1972a; Vermeer et al., 1973).

These factors interact to cause considerable variation in the number of birds affected at a given site from season to season, or from year to year (Chupp and Dalke, 1964). Consequently , some researchers have concluded "...it is clear that lethal hazard cannot be predicted solely on the basis of chemical hazard" (Hill et al., 1975), "...in the last few years, it has become especially clear that it is less the total concentration of a certain element that produces a negative or positive effect on the organism, but rather the specific compound form that decisively influences the toxic effect of an element" (Forstner and Wittman, 1983). For these reasons, some researchers (e.g. Heinz, 1976) have examined the effects of metals on waterfowl under controlled laboratory conditions, then cautioned that similar effects (even though not lethal in the laboratory) may be deleterious under field conditions because they effect the behavior or reproductive success of the birds. At the same time, these influences may not be deleterious at all.

If it is so difficult to predict the probability of passage of metals contaminants through the aquatic ecosystem to waterfowl, it is even more difficult to predict the liklihood of contaminant passage from waterfowl to humans. This difficulty is reflected by the paucity of literature references on the subject.

3.2.1 Lead

There has been considerable research done on the effects of lead poisoning in waterfowl, mostly in reference to the ingestion of lead shot. It should be noted that lead shot ingestion is not a problem at Upper Lake, since there is no public access and consequently no deposition of lead shot by waterfowl hunters.

Lead chemistry is complex (Eisler, 1988a). Most lead entering natural waters is precipitated to the sediment bed as carbonates or hydroxides. In sediments, lead is mobilized and released when pH decreases suddenly or ionic composition changes. Methylization of lead in sediments is positively correlated to increasing temperatures, soft water, reduced pH and microbial activity, but seems to be independent of lead concentration (Eisler, 1988a). These conclusions suggest that methylization seldom occurs at Upper Lake even though lead concentrations in sediments are elevated, because the water is hard, temperatures are comparatively low and constant, and pH is slightly alkaline (Appendix 1).

Chupp and Dalke (1964) examined lead poisoning in waterfowl near mining activity in Idaho, and concluded that non-soluble lead was in bottom sediments, and was being picked up by birds either through ingestion of plants or sediments. However, Erickson and Lindzey (1983) found levels of lead in cattails to fluctuate dramatically between tissues within a plant, as well as between plants. Behan et al. (1979) found that

"...even though rooted aquatic plants can absorb lead from soils containing metallic lead or lead shot, they do not appear to accumulate lead in concentrations sufficiently high to be a dietary factor leading to plumbism in waterfowl." Eisler (1988a) reported that "...ingestion of food containing biologically incorporated lead...is unlikely in itself to cause clinical lead poisoning. A similar case is made for powdered lead and forms of lead other than shot; the strong indication is that the form in which lead is ingested is crucial..." and "...in general, forms of lead other than shot (and ingestible lead objects)...are unlikely to cause clinical signs of lead poisoning in birds." For example, Finley et al. (1975?) fed first-year mallard drakes various concentrations of lead nitrate. Although they found ALAD inhibition (discussed below) there was no mortality due to lead ingestion. Treated groups and controls did not differ in body weights, food consumption, hemoglobin, hematocrit, or the presence of tissue lesions.

Lead accumulates in the blood, kidney, liver and bones of waterfowl (Anderson, 1975). It inhibits a precursor enzyme in the blood called delta-aminolevelinic acid dehydratase (ALAD), which in turn affects other functions that result in lead poisoning (Dieter and Finley, 1978). Absorption and retention of lead from the gastrointestinal tract varies widely because of the age, sex and diet of the bird. Diet is the major modifier of lead absorptions and of toxic effects in many species of waterfowl (Eisler, 1988a).

Many species of waterfowl that have precocial hatchlings are relatively tolerant to moderate exposure to lead. Eisler (1988a) reported that mallards showed no effect on growth at dietary levels of 500 ug/kg, or survival at 2,000 ug/kg. Demayo et al. (1981) found that at levels of dietary ingestion, mallards did not show ALAD inhibition until exposures reached 12 weeks (it should be noted that dietary levels are far below the exposures associated with the ingestion of even one lead shot pellet).

Lead does not result in eggshell thinning, although if it results in an altered diet, the diet may then result in thinner eggshells. Lead does not biomagnify through the food chain (Demayo et al., 1981). Thus, eagles and other avian predators that have died from lead poisoning have consumed lead shot in their prey, rather than biologically incoporated lead (Eisler, 1988a).

In terms of human consumption of lead-poisoned waterfowl, since lead accumulates in waterfowl bones and organs, rather than muscle tissue, there is little or no danger to human receptors. Furthermore, since ingestion of food containing biologically incorporated lead is unlikely to cause lead poisoning in waterfowl (Eisler, 1988a), it is even more unlikely that consuming these birds will be harmful to humans since lead does not biomagnify. Indeed, the publications reviewed did not report lead concentrations in bird muscle tissue, undoubtedly because they were insignificant if present at all. Finally, the number of waterfowl that reside at Upper Lake long enough to consume sufficient quantities of lead to create any form of hazard either to themselves or to humans is very small.

In summary, lead poisoning in waterfowl at Upper Lake and consumption of these birds by humans is not expected to be a problem because: 1) Upper Lake does not have the physical and chemical characteristics (i.e., elevated temperature, low pH, soft water) conducive to mobilizing lead from sediments; 2) in general, forms of lead other than shot are unlikely to cause lead poisoning in waterfowl, further reducing the potential for effects to humans; 3) birds must be exposed to considerable dosages of biologically incorporated lead for relatively long periods of time, suggesting that waterfowl that use Upper Lake only during the fall migration have not been present long enough to consume enough lead to be a hazard; 4) in general, humans do not consume the parts of waterfowl that concentrate lead; 5) there is no public access to Upper Lake, so that there should not be any hunting of birds at the pond itself; and 6) assuming that waterfowl that reside at Upper Lake all summer are shot by hunters at other locations, these birds undoubtedly contain so little lead and make up such a small proportion of the hunter's bag, that they do not represent a health hazard.

3.2.2 MERCURY

The known effects of mercury poisoning in birds include anorexia, loss of weight, blindness, ataxia (failure of muscular coordination), partial paralysis, reduced egg production and hatchability, thin eggs shells, and death (Braun et al., 1977). Heinz (1976) found that at non-lethal levels, methyl mercury contamination resulted in abnormal egg-laying behavior, impaired reproduction, high food consumption by adults, and slowed duckling growth. While none of these was necessarily lethal to the individual, they could make ducks more susceptible to predation, other diseases, lowered reproduction, etc. that would be deleterious to the population.

Methyl mercury is the most toxic form; total mercury content is not a satisfactory indicator of the levels of methyl mercury, because methyl mercury fractions vary greatly between bird species, age groups, etc. (Fimreite, 1974). All forms of mercury may be converted into methyl mercury. According to Tolin (1975), the methylation process usually occurs in sediments of streams and lakes, and is thought to occur through the action of methogenic bacteria, but is also affected by pH and the amount of organic matter in the water. Highly alkaline waters, for example, retard the methylation process (Peterson and Ellarson, 1976).

Mercury is passed through the food chain. D'Itri (1971) reported that aquatic plants can be an important factor in the translocation of mercury from contaminated sediments. Vermeer et al. (1973) found that mayfly nymphs, water scorpions, water boatmen, crayfish and yellow perch were all highly contaminated by mercury, apparently as a result of their predatory habits of feeding on smaller aquatic organisms.

Consequently, the waterfowl (particularly mergansers) that fed on these animals had higher mercury levels than those that did not. Peterson and Ellarson (1976) recorded similar results in oldsquaws, which feed on bottom-dwelling invertebrates.

The toxicity of mercury to birds increases by trophic level. For instance, waterfowl often contain comparatively high levels of residues with little effect, while liver mercury residues as low as 17 ppm have been known to be lethal to adult red-tailed hawks (Fimreite and Karstad, 1971). Furthermore "...the significance of mercury residues in birds is not fully understood...it is not now possible to implicate mercury as a major cause of unsuccessful eagle reproduction" (Eisler, 1987).

Methyl mercury is a highly stable organic compound. It is therefore accumulated primarily in the liver and kidney of waterfowl, and because it is not rapidly excreted, subsequently is accumulated in the muscles (Hesse et al., 1975). Mercury is then deposited gradually in the feathers. Peterson and Ellarson (1976) concluded that "...the tendency for mercury to be transported from body tissues to feathers is so strong that eventually all the mercury can be eliminated in this manner," i.e., when the bird molts its feathers, the mercury is lost. Hoffman and Curnow (1979) discovered that primary wing feathers of adult great blue herons, black-crowned night herons and great egrets contained the highest residue levels of mercury followed by liver, breast muscle and brain tissue. In contrast, Eisler (1987) reported that residues were generally highest in the brain, followed by the liver, kidney, muscle and carcass. Vermeer and Armstrong (1972b) found that breast muscles contained higher residues than wing muscles, but that the two were positively correlated.

Other forms of mercury also accumulate. For example, Hesse et al. (1975) found that piscivorous waterfowl accumulated higher residues in the liver, while non-fisheating waterfowl had higher kidney mercury levels. They concluded that this difference was due to different forms of mercury being ingested, and accumulating differently in different species. Other metals also have an influence. Ohlendorff et al. (1986) reported that dietary selenium increased mercury concentrations in tissues and eggs, and dietary mercury increased selenium concentration in tissues.

A number of studies have reported that mercury levels are highest among fish-eating waterfowl such as mergansers, followed by diving ducks and then dabbling ducks (Eisler, 1987; Hesse et al., 1975; Ohlendorff et all., 1986; Pearce et al., 1976; Swanson et al. 1972; Vermeer and Armstong, 1972a; Vermeer et al., 1973). This is primarily due to diet. For example, "...with the help of various bacteria, fish can methylate inorganic mercury directly in the intestines and in the slime on the outside of the fish. This lends credence to the statement that practically all the mercury in fish is of the methylated form, which would suggest methyl mercury contamination in fish-eating birds" (Hesse et al., 1975). However, Fimreite (1974) reported that "...in contrast to what has been generally found for fish, however, the bulk of the mercury in a typical fisheater like the common merganser did not occur in a methyl form." This latter result may also mean that these birds accumulated other, less toxic forms of mercury.

Accumulation is obviously affected by the locality. For example, Vermeer (1971) reported higher residues of mercury in the eggs of late-laying dabbling and diving ducks than in eggs of species laying early at the same locale. This indicated that mercury contamination was occurring at the breeding site, rather than during migration. Diet and migration are therefore the two most important mercury modifiers in birds (Eisler, 1987).

Just as mercury accumulates comparatively rapidly in watefowl, it is eliminated relatively rapidly (2-3 months) particularly if the birds migrate to uncontaminated areas (D'Itri et al., 1978). Braun et al. (1977) observed mercury levels in band-tailed pigeons decrease significantly within one year after use of mercury as a fungicide was halted.

Based on the above review, mercury in waterfowl at Upper Lake does not pose a threat to human receptors because: 1) mercury values in Upper Lake sediments and water are low and very low, respectively (Appendix 1); 2) Upper Lake is slightly alkaline, which retards the methylation of mercury into its most toxic form; 3) some studies indicate that waterfowl may not concentrate harmful levels of methyl mercury even if they have been consuming it in fish and invertebrates; 4) birds in Upper Lake must have fed in the pond long enough to accumulate mercury in muscle tissues rather than organ tissues. This would preclude migrants that use the pond only during fall, when they might be potentially harvested by hunters; 5) because public access to Upper Lake is prohibited, hunters cannot readily harvest these birds; and 6) a sufficient quantity of contaminated tissue must be consumed by human receptors. The recommended criterion for mercury in waterfowl breast tissue is <1,000 ug/kg fresh weight (Lindsay and Dimmick, 1983). Of the papers examined for this literature review, only three reported values of more than 1,000 ug/kg in duck muscle tissue, suggesting that the incidence of such high values in waterfowl is quite low.

3.3.3 CADMIUM

Like mercury, cadmium tends to concentrate in bottom sediments, from which it is passed on to invertebrates and fish, and then to waterfowl; highest values of cadmium in sediments occur during spring runoff (Van Hassel et al., 1980). Plants such as cattails may also accumulate cadmium, although with great variability between individual plants (Erickson and Lindzey, 1983).

In waterfowl, cadmium accumulates in the kidney and liver (White and Finley, 1978). Unlike lead, it does not accumulate in bones and concentrations in muscle tissue are usually low (DiGuilio and Scanlon, 1984). At the Warms Springs Ponds in Montana, cadmium concentrations in muscle tissue were not significantly different from those of control birds (Trout et al., 1986).

According to Eisler (1985)..."birds are comparatively resistant to the biocidal properties of cadmium...ducks...contaminated with high levels of cadmium, as well as zinc and copper, were apparently protected from the deleterious effects of high metal body burdens by metallothioneins. Amounts of these metal-binding proteinaceous metallothioneins and heavy metal loading appear to depend primarily on the degree of pollution and secondarily on the species of animal and its position in the food web. Ducks contained the highest levels of metallothioneins of all groups examined."

In waterfowl, cadmium does not accumulate in eggs of laying hens, but egg production may be lowered due to overall decline of the hen (White and Finley, 1978). White et al. (1978) fed mallards varying dosages of cadmium chloride (2, 20 and 200 ppm) for 30, 60 or 90 days. No birds died during the experiment and body weights did not change. Only the highest dosage (200 ppm) over the longest period (90 days) had any effect, and resulted in slight to severe kidney lesions and atrophy of testes. Thus, waterfowl have to consume compartively high concentrations of cadmium for a considerable time before deleterious effects are evident.

Cadmium influences the uptake of other metals. DiGuilio and Scanlon (1984) found that cadmium ingestion increased the kidney concentrations of copper and zinc, a behavior that was not observed with lead ingestion. The addition of zinc, iron, ascorbic acid, calcium or selenium to diets amerliorated cadmium damage effects, whereas addition of lead or mercury exacerbated them (Eisler, 1985). However, Eisler (1985) warned that it is difficult to interpret the effects of cadmium residues in the presence of other metals contaminants.

As with other metals, cadmium concentrations are greater in omnivorous or carnivorous waterfowl than in herbivorous species, due to accumulation through the food chain (DiGuilio and Scanlon, date uncertain). Trout et al. (1986) reported that diving ducks at the Warm Springs Ponds in Montana had significantly higher muscle cadmium concentrations that dabbling ducks, but also stated that even in the worst case basis, humans would have to eat almost a pound of duck meat per week in order to reach the Food and Agriculture Organization/World Health Organization (FAO/WHO) provisional standard of 500 ug/week.

With regard to the effect of human consumption of waterfowl contaminated by cadmium, Ryan et al. (1982) reported that cadmium accumulates in humans in the kidney (from diet) and lungs (from smoking). Furthermore, there is a considerably greater risk from eating plants contaminated by cadmium, than from eating animals: "...the impact of increasing soil cadmium on the movement of cadmium from soil to plant to animal to human would indicate little reason for concern. In contrast, the movement of cadmium from soil to plant to human can be of concern. The degree of risk is dependent upon the amount of the diet which is affected, diet selection of the individual, soil pH at which the crop is produced, and the amount of cadmium added to the soil" (Ryan et al., 1982). As stated earlier, Trout et al. (1986) examined cadmium concentrations in muscle tissues of waterfowl at the Warm Springs Ponds in Montana, and found that a person would have to eat nearly a pound of duck meat per week to reach the FAO/WHO weekly standard for consumption, based on the highest concentrations of cadmium found. Using the average cadmium conentration found in waterfowl muscle tissue at the Warm Springs Ponds, a person would have to eat 7.3 pounds of duck meat per week to reach the FAO/WHO standard. Furthermore, since cadmium concentrations in Upper Lake sediments are less than half of the Warm Springs Ponds average value (Table 2), it follows that tissue levels from Upper Lake waterfowl are even less than from Warm Springs Ponds waterfowl.

Therefore, it is remote that cadmium in Upper Lake represents a threat to either waterfowl or human receptors because: 1) hunting is not allowed at Upper Lake, further reducing the liklihood of human exposure; 2) the number of waterfowl that feed in Upper Lake long enough (at least 90 days) to accumulate cadmium is very low; 3) cadmium accumulates in parts of the waterfowl that are not generally eaten by human receptors; 4) cadmium residues in waterfowl muscle are very low, indicating that human receptors would have to eat large quantities of these birds in order to ingest deleterious amounts of cadmiun. There are not enough birds at Upper Lake to supply these quantities.

3.3.4 ARSENIC

Arsenic is a relatively common element, present in air, water, soil and all living tissue. It is constantly being oxidized, reduced or otherwise metabolized (Eisler, 1988b). It has a short half-life in fish. In one test, residues in exposed rainbow trout were the same as those in unexposed controls after 28 days (EPA, 1980). The same may be true in waterfowl; for example, Trout et al. (1986) found no difference in arsenic concentrations between control waterfowl and those collected from the Warms Springs Ponds in Montana. They further reported that arsenic did not appear to be differentially distributed between muscle and liver tissue. No differences were noted between males and females, or between diving ducks, dabbling ducks or geese.

Arsenic is bioconcentrated by organisms but is not biomagnified in the food chain; episodes of arsenic poisoning are either acute or subacute, and chronic cases of arsenosis are seldom encountered in any species but man (Eisler, 1988b). In humans, arsenic is the least chronically toxic of the four metals examined in this literature review (EPA, 1980).

Arsenic can pass through the food chain from sediments to zooplankton to invertebrates to fish (Forstner and Wittman, 1983). However, the form of arsenic that is concentrated is important. Oscarson et al. (1980) found that sediments may abiotically oxidize arsenite to arsenate, which is considerably less toxic. In humans, "...excretion of arsenate is faster than of arsenite, mostly in urine. Arsenate has a low order of toxicity and does not inhibit any enzyme system..." (Forstner and Wittman, 1983).

Trout et al. (1986) found that arsenic was not at elevated levels in Warm Springs Ponds waterfowl; indeed, none of the Warm Springs Ponds samples exceeded 56% of the USDA standard of 0.50 ppm. Arsenic in the sediments of Upper Lake is only about one-fourth as concentrated as the average arsenic value from the Warm Springs Ponds (Table 2). Thus, arsenic in Upper Lake waterfowl should be at even lower levels than in Warm Springs Ponds waterfowl.

Very few publications were found that specifically addressed arsenic contamination in waterfowl. Based on the papers that were reviewed, however, it can be concluded that arsenic in Upper Lake does not pose a threat to human consumers of waterfowl because: 1) the form of arsenic being consumed by waterfowl (and therefore, by humans) may not be highly toxic; 2) waterfowl metabolize and excrete arsenic relatively rapidly; 3) arsenic generally does not differentially accumulate in muscle tissue of waterfowl; and 4) as in the discussion of other metals, it should be noted that waterfowl hunting is not allowed at Upper Lake, and the numbers of waterfowl that reside at Upper Lake long enough to accumulate arsenic are very low.

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4.0 CONCLUSIONS

A literature review was conducted to examine the toxicity of lead, mercury, cadmium and arsenic in the sediments of Upper Lake to waterfowl using the lake, and to humans that might consume the waterfowl. The review found that: 1) there are so many biotic and abiotic variables influencing the pathway from sediments to waterfowl to humans that there are no general correlations between the concentrations of metals contaminants in sediments or water with those in waterfowl; 2) the physical and chemical properties of Upper Lake are not conducive to methylization of lead from sediments, reducing the potential for impact to waterfowl and/or humans; 3) levels of mercury in Upper Lake sediments and water are so low that the potential for impact to waterfowl or humans is also low. In addition, the chemical properties of Upper Lake are not conducive to the methylation of mercury into its more toxic forms; 4) waterfowl must be exposed to high concentrations of cadmium for long periods before deleterious effects become evident. Cadmium does not accumulate in parts of the waterfowl that are generally eaten by humans. Therefore, humans would have to eat large quantities of waterfowl to ingest deleterious amounts of cadmium, and Upper Lake does not support sufficient numbers of waterfowl to supply these amounts; and 5) arsenic is metabolized and excreted by waterfowl rapidly and does not generally accumulate in muscle tissue, thereby reducing the threat to human receptors. These factors, combined with the low numbers of waterfowl at Upper Lake and the fact that human access to Upper Lake is restricted so that hunters cannot harvest these waterfowl, indicate that there is little need for concern about the four contaminants examined.

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APPENDIX 1. BOTTOM SEDIMENT AND WATER QUALITY DATA FOR UPPER LAKE.

0211164

SUMMARY OF STREAM BOTTOM SEDIMENT ANALYSIS - ASARCO EAST HELENA

SAMPLING SITE	UPPER LAKE	LOWER LAKE	LOWER LAKE	LOWER LAKE	THORNOCK LAKE	THORNOCK LAKE	THORNOCK LAKE	THORNOCK LAKE	THORNOCK LAKE	WD-2
SAMPLE DATE	06/06/85	11/08/84	11/08/84	06/06/85	11/08/84	11/08/84	11/08/84	11/08/84	06/05/85	11/07/84
LAB	ASARCO	ASARCO	CAL	ASARCO	ASARCO	ASARCO	CAL	CAL	ASARCO	ASARCO
REMARKS	REPLICATE					REPLICATE		REPLICATE		
SAMPLE NUMBER	8506-507	8411-37	8411-37	8506-529	8411-38	8411-43	8411-38	8411-43	8506-530	8411-29
TRACE ELEMENTS										
ALUMINUM (AL)			11400				2580	1320		
ANTIMONY (SB)	(10	(10	(0.7	(10	3575	8250	461	1450	2125	(10
ARSENIC (AS)	127	700	224	2800	39500	70000	6100	24300	24500	2650
BARIUM (BA)	130	175	102	170	60	(25	11	28	(25	255
BERYLLIUM (BE)			0.9				0.65	0.24		
CADMIUM (CD)	70	95	18	600	25000	49250	2950	17600	12000	300
CHROMIUM (CR)	50	40	13	70	50	40	14	11	165	75
COBALT (CO)	16	20	10	28	140	160	60	70	120	33
COPPER (CU)	405	410	133	2000	16500	18250	10600	9000	12750	640
IRON (FE)	45000	50000	18800	50000	27500	26500	21500	12200	29500	33750
LEAD (PB)	1925	2100	560	10750	15500	27500	33250	38300	25333	4650
MANGANESE (MN)	950	1150	375	1400	2600	2800	1340	990	2500	2300
MERCURY (HG)	3.2	6.0	1.1	4.0	0.70	0.085	85	1.4	0.35	7.9
NICKEL (NI)			9				38	65		
SELENIUM (SE)			(0.12				0.65	2.1		
SILVER (AG)	14	9.0	2.6	110	550	550	266	22	675	40
THALLIUM (TL)			1.1				177	199		
TIN (SN)			(1.8				50	16		
VANADIUM (V)	(100	125	36	(100	(100	(100	8	4.4	(100	(100
ZINC (ZN)	2950	2900	650	7000	42500	60000	37900	15400	26250	3075

ALL QUANTITIES IN PARTS PER MILLION UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED

OUTPUT DATE: 12/18/85

SUMMARY OF SURFACE WATER QUALITY ANALYSES - ASARCO EAST HELENA

0211165

SITE NAME	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	WD-1	WD-1	WD-2
SAMPLE DATE	11/07/84	11/07/84	11/07/84	04/04/85	06/06/85	06/06/85	08/06/85	05/08/85	05/08/85	04/18/85
LAB	ASARCO	CAL	CAL	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	JTC	ASARCO
REMARKS	REPLICATE		REPLICATE			REPLICATE				
SAMPLE NUMBER	8411-40	8411-36	8411-40	8504-309	8506-528	8506-507	8508-736	8505-453	8505-453	8504-341
PHYSICAL PARAMETERS										
SPEC. COND. (UMHOS/CM) FIELD	296.8			262.5	228.4	228.4	327.8	216.9		
SPEC. COND. (UMHOS/CM) LAB	165	190	192	279	213		340	234	102	
PH LAB	8.0	8	8	6.4	7.7		8.2	7.4	7.48	
TOTAL SUSP. SOLIDS		7	16	14.4	9.9		2.8	5.8	4	
TDS MEAS. @ 180 DEG. C	198	240	200	190	165		221	157	30	
COMMON IONS										
CALCIUM (CA)	35	28.4	27.5	29	25		31	25	22.6	
MAGNESIUM (MG)	8.3	6.76	<0.368	6.8	6.2		8.6	5.7	4.86	
SODIUM (NA)	13	20.2	18.4	13	12.8		20	13.7	11.6	
POTASSIUM (K)	2.8	1.84	1.02	3.5	2.4		3.9	2.3	3.36	
ALKALINITY AS CACO3 (LAB)	92	100	94	72	70.6		102	60.2	62.5	
BICARBONATE (HCO3) (LAB)	112	122	115	88	86		124	73	76	
SULFATE (SO4)	563	51	52	41.9	36.7		50.5	41.1	34.3	
CHLORIDE (CL)	6.3	5	4	2.3	<2		4.6	3.3	2.0	
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL		<0.161	0.274						0.150	
ALUMINUM (AL) DISS		0.314	<0.161						<0.136	
ANTIMONY (SB) TOTAL		<0.014	<0.014						<0.052	
ANTIMONY (SB) DISS		<0.014	<0.014						<0.052	
ARSENIC (AS) TOTAL	0.009	0.010	0.011	0.013	0.013	0.010	0.019	0.022	<0.0067	0.012
ARSENIC (AS) DISS	0.004	0.014	0.006	<0.001	0.007	0.009	0.016	0.011	<0.0067	0.006
BARIUM (BA) TOTAL		0.030	0.029						0.023	
BARIUM (BA) DISS		0.026	0.026						0.028	
BERYLLIUM (BE) TOTAL		<0.0006	<0.0006						<0.0049	
BERYLLIUM (BE) DISS		<0.0006	<0.0006						<0.0049	
CADMIUM (CD) TOTAL	0.004	<0.004	<0.004	0.001	0.003	0.003	0.001	<0.001	0.004	0.005
CADMIUM (CD) DISS	0.003	<0.004	<0.004	<0.001	0.001	<0.001	<0.001	<0.001	<0.0036	0.004
CHROMIUM (CR) TOTAL		<0.0021	0.0049						<0.0079	
CHROMIUM (CR) DISS		<0.0021	<0.0021						<0.0079	
COBALT (CO) TOTAL		<0.0069	<0.0069						<0.020	
COBALT (CO) DISS		<0.0069	<0.0069						<0.020	
COPPER (CU) TOTAL	0.008	0.0059	0.0067	0.011	0.024	0.024	0.009	0.013	<0.015	0.020
COPPER (CU) DISS	<0.008	0.0067	0.021	<0.008	0.013	0.009	0.008	0.009	<0.015	0.008
IRON (FE) TOTAL	0.540	0.083	0.480	1.05	0.263	0.763	0.550	0.425	0.394	0.838
IRON (FE) DISS	0.100	0.573	0.141	0.110	0.025	0.035	0.038	0.200	<0.041	0.125
LEAD (PB) TOTAL	0.014	<0.003	0.0061	0.022	0.088	0.050	0.022	0.021	0.020	0.063
LEAD (PB) DISS	0.005	0.083	0.051	<0.005	<0.005	<0.005	<0.005	0.016	<0.0024	0.009
MANGANESE (MN) TOTAL	0.170	0.164	0.157	0.110	0.074	0.089	0.126	0.118	0.147	0.223

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 05-10-1988

0211166

SUMMARY OF SURFACE WATER QUALITY ANALYSES - ASARCO EAST HELENA

SITE NAME	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	VD-1	VD-1	VD-2
SAMPLE DATE	11/07/84	11/07/84	11/07/84	01/04/85	06/06/85	06/06/85	08/06/85	05/08/85	05/08/85	04/18/85
TRACE ELEMENTS										
MANGANESE (MN) DISS	0.170	0.142	0.144	0.084	0.066	0.069	0.084	0.099	0.109	0.178
MERCURY (HG) TOTAL		<0.00019	<0.00019						0.00014	
MERCURY (HG) DISS		<0.00019	<0.00019						0.00025	
NICKEL (NI) TOTAL		<0.034	<0.034						<0.018	
NICKEL (NI) DISS		<0.034	<0.034						<0.018	
SELENIUM (SE) TOTAL		<0.0024	<0.0024						<0.0039	
SELENIUM (SE) DISS		<0.0021	<0.0024						<0.0039	
SILVER (AG) TOTAL		<0.0026	<0.0026						<0.0096	
SILVER (AG) DISS		<0.0026	<0.0026						<0.0096	
THALLIUM (TL) TOTAL		<0.0021	<0.0021						<0.100	
THALLIUM (TL) DISS		<0.0021	<0.0021						<0.100	
TIN (SN) TOTAL		<0.036	<0.036						<0.034	
TIN (SN) DISS		<0.036	<0.036						<0.034	
VANADIUM (V) TOTAL		<0.0035	0.0049						<0.033	
VANADIUM (V) DISS		<0.0035	<0.0035						<0.033	
ZINC (ZN) TOTAL	0.030	0.033	0.057	0.071	0.079	0.108	0.030	0.040	0.063	0.135
ZINC (ZN) DISS	0.030	0.052	0.035	0.044	0.041	0.013	0.008	0.036	0.034	0.073

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 05-10-1988

0211167

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO EAST HELENA

SAMPLING SITE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE
SAMPLE NUMBER	8411-36	8411-40	8411-36	8411-40	8504-309	8506-528	8506-507	8508-736
SAMPLE DATE	11/07/84	11/07/84	11/07/84	11/07/84	04/04/85	06/06/85	06/06/85	08/06/85
LAB	ASARCO	ASARCO	CAL	CAL	ASARCO	ASARCO	ASARCO	ASARCO
REMARKS		REPLICATE		REPLICATE			REPLICATE	
PHYSICAL PARAMETERS								
SPEC. COND. (UMHOS/CM) FIELD	298.9	296.8			262.5	228.4	228.4	327.8
SPEC. COND. (UMHOS/CM) LAB	170	165	190	192	279	243		340
PH LAB	8.0	8.0	8	8	6.4	7.7		8.2
TOTAL SUSP. SOLIDS			7	16	14.4	9.9		2.8
TDS MEAS. @ 180 DEG. C	194	198	240	200	190	165		221
COMMON IONS								
CALCIUM (CA)	34	35	28.4	27.5	29	25		34
MAGNESIUM (MG)	8.2	8.3	6.76	<0.368	6.8	6.2		8.6
SODIUM (NA)	13	13	20.2	18.4	13	12.8		20
POTASSIUM (K)	3.0	2.8	1.84	1.02	3.5	2.4		3.9
ALKALINITY AS CACO3 (LAB)	94	92	100	94	72	70.6		102
BICARBONATE (HCO3) (LAB)	115	112	122	115	88	86		124
SULFATE (SO4)	49	563	51	52	41.9	36.7		50.5
CHLORIDE (CL)	6.3	6.3	5	4	2.3	<2		4.6
TRACE ELEMENTS								
ALUMINUM (AL) TOTAL			<0.161	0.274				
ALUMINUM (AL) DISS			0.314	<0.161				
ANTIMONY (SB) TOTAL			<0.014	<0.014				
ANTIMONY (SB) DISS			<0.014	<0.014				
ARSENIC (AS) TOTAL	0.013	0.009	0.010	0.011	0.013	0.013	0.010	0.019
ARSENIC (AS) DISS	0.008	0.004	0.014	0.006	<0.004	0.007	0.009	0.016
BARIUM (BA) TOTAL			0.030	0.029				
BARIUM (BA) DISS			0.026	0.026				
BERYLLIUM (BE) TOTAL			<0.0006	<0.0006				
BERYLLIUM (BE) DISS			<0.0006	<0.0006				
CADMIUM (CD) TOTAL	0.001	0.004	<0.004	<0.004	0.001	0.003	0.003	0.001
CADMIUM (CD) DISS	<0.001	0.003	<0.004	<0.004	<0.001	0.001	<0.001	<0.001
CHROMIUM (CR) TOTAL			<0.0021	0.0049				
CHROMIUM (CR) DISS			<0.0021	<0.0021				
COBALT (CO) TOTAL			<0.0069	<0.0069				
COBALT (CO) DISS			<0.0069	<0.0069				
COPPER (CU) TOTAL	0.008	0.008	0.0059	0.0067	0.011	0.024	0.024	0.009
COPPER (CU) DISS	<0.008	<0.008	0.0067	0.021	<0.008	0.013	0.009	0.008
IRON (FE) TOTAL	0.440	0.540	0.083	0.480	1.05	0.263	0.763	0.550
IRON (FE) DISS	0.110	0.100	0.573	0.141	0.110	0.025	0.025	0.038
LEAD (PB) TOTAL	0.015	0.014	<0.003	0.0061	0.022	0.088	0.050	0.022
LEAD (PB) DISS	<0.005	0.005	0.083	0.051	<0.005	<0.005	<0.005	<0.005

ALL QUANTITIES IN MILLIGRAMS PER LITER UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED
SAMPLE NUMBER PREFIX IS 'AEH'.
OUTPUT DATE: 12/26/85

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO EAST HELENA

SAMPLING SITE / SAMPLE DATE	UPPER LAKE 11/07/84	UPPER LAKE 11/07/84	UPPER LAKE 11/07/84	UPPER LAKE 11/07/84	UPPER LAKE 04/04/85	UPPER LAKE 06/06/85	UPPER LAKE 06/06/85	UPPER LAKE 08/06/85
TRACE ELEMENTS								
MANGANESE (MN) TOTAL	0.200	0.170	0.164	0.157	0.140	0.074	0.089	0.126
MANGANESE (MN) DISS	0.180	0.170	0.142	0.144	0.084	0.066	0.069	0.084
MERCURY (HG) TOTAL			<0.00019	<0.00019				
MERCURY (HG) DISS			<0.00019	<0.00019				
NICKEL (NI) TOTAL			<0.034	<0.034				
NICKEL (NI) DISS			<0.034	<0.034				
SELENIUM (SE) TOTAL			<0.0024	<0.0024				
SELENIUM (SE) DISS			<0.0024	<0.0024				
SILVER (AG) TOTAL			<0.0026	<0.0026				
SILVER (AG) DISS			<0.0026	<0.0026				
THALLIUM (TL) TOTAL			<0.0021	<0.0021				
THALLIUM (TL) DISS			<0.0021	<0.0021				
TIN (SN) TOTAL			<0.036	<0.036				
TIN (SN) DISS			<0.036	<0.036				
VANADIUM (V) TOTAL			<0.0035	0.0049				
VANADIUM (V) DISS			<0.0035	<0.0035				
ZINC (ZN) TOTAL	0.060	0.030	0.033	0.057	0.071	0.079	0.108	0.030
ZINC (ZN) DISS	0.040	0.030	0.052	0.035	0.044	0.041	0.043	0.008

ALL QUANTITIES IN MILLIGRAMS PER LITER UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED
SAMPLE NUMBER PREFIX IS 'AEH'.
OUTPUT DATE: 12/26/85

0211169

SUMMARY OF STREAM BOTTOM SEDIMENT ANALYSIS - ASARCO EAST HELENA

SAMPLING SITE	PPC-8	PPC-8	PPC-9	PPC-9	PPC-9	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE	UPPER LAKE
SAMPLE DATE	05/07/85	05/08/85	11/05/84	11/05/84	05/07/85	11/07/84	11/07/84	11/07/84	11/07/84	06/06/85
LAB	ASARCO	ASARCO	ASARCO	CAL	ASARCO	ASARCO	ASARCO	CAL	CAL	ASARCO
REMARKS		REPLICATE					REPLICATE		REPLICATE	
SAMPLE NUMBER	8505-435	8505-405	8411-27	8411-27	8505-436	8411-36	8411-40	8411-36	8411-40	8506-528
<u>TRACE ELEMENTS</u>										
ALUMINUM (AL)				9100				6050	8050	
ANTIMONY (SB)	(10	(10	(10	(0.7	(10	(10	(10	0.75	(0.7	(10
ARSENIC (AS)	18	30	53	60	18	264	108	75	70	83
BARIUM (BA)	35	110	150	110	100	95	(25	65	122	115
BERYLLIUM (BE)				0.95				0.48	0.7	
CADMIUM (CD)	1.5	3.5	19	6	3.5	65	26	12	8	48
CHROMIUM (CR)	70	45	105	12	105	75	50	7	12	45
COBALT (CO)	(10	(10	12	6.5	(10	18	24	5.5	7.5	16
COPPER (CU)	38	70	135	75	80	330	290	112	115	280
IRON (FE)	16750	20000	35000	16800	25500	38750	48500	8600	23600	40500
LEAD (PB)	130	255	690	400	300	4150	1675	685	494	1350
MANGANESE (MN)	1300	1450	2850	1480	1650	900	1050	660	274	800
MERCURY (HG)	0.10	0.10	3.2	0.75	0.12	15	0.70	7.5	2.6	2.5
NICKEL (NI)				8.5				5.5	7	
SELENIUM (SE)				(0.12				(0.12	(0.12	
SILVER (AG)	(2.5	(2.5	4.0	3.7	(2.5	9.0	6.5	2	2.4	7.5
THALLIUM (TL)				0.50				0.65	0.42	
TIN (SN)				(1.8				(1.8	(1.8	
VANADIUM (V)	(100	(100	(100	26	(100	(100	155	20	34	(100
ZINC (ZN)	325	600	1650	1320	1425	2550	1700	825	461	2125

ALL QUANTITIES IN PARTS PER MILLION UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED

OUTPUT DATE: 12/18/85

APPENDIX 5-6

QUALITATIVE ASSESSMENT OF WILDLIFE USE OF WETLANDS IN THE UPPER LAKE VICINITY

0211171

QUALITATIVE ASSESSMENT OF WILDLIFE USE OF WETLANDS IN THE UPPER LAKE VICINITY

For:

ASARCO, Inc.
P.O. Box 1230
East Helena, MT 59635

By:

Western Technology and Engineering, Inc.
3005 Airport Rd.
P.O. Box 6045
Helena, MT 59604

November, 1989

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QUALITATIVE ASSESSMENT OF WILDLIFE USE OF WETLANDS IN THE UPPER LAKE VICINITY

1.0 INTRODUCTION

To meet its obligations under the Fish and Wildlife Coordination Act and the Endangered Species Act, in 1988 the Environmental Protection Agency (EPA) consulted the U.S. Fish and Wildlife Service (USFWS) about the Asarco East Helena Comprehensive Remedial Investigation. USFWS' concerns were primarily related to the potential impacts to wildlife resources presently using the Upper Lake area, if some form of remedial action was required at the lake. Therefore, a site visit and meeting between Asarco, USFWS, Montana Department of Health and Environmental Sciences (MDHES), Hydrometrics, Inc. and Western Technology and Engineering, Inc. (WESTECH) personnel was held at the East Helena plant on December 8, 1988. It was followed on February 14, 1989 by a meeting between USFWS, EPA, Asarco, Hydrometrics and WESTECH personnel at the USFWS office in Helena, during which USFWS' specific concerns were outlined and a plan of study to assess wildlife use of the Upper Lake vicinity was developed.

Since the regulatory agencies were primarily interested in waterfowl and migratory bald eagle and peregrine falcon use of the Upper Lake vicinity, the study was limited to the time period from ice-out through early June to coincide with migration and early nesting. Wetlands of the Upper Lake vicinity were to be mapped according to USFWS methodology (Cowardin et al., 1979), wildlife use of these wetlands was to be qualitatively assessed, and this information was to be compared with other, similar sites located on Prickly Pear Creek upstream from the East Helena plant.

2.0 METHODS

As agreed during the February 14 meeting, field work consisted of a site visit by WESTECH's biologist approximately every two weeks from early March through early June. These dates were March 15 and 24, April 8 and 19, May 4 and 17, and June 2.

Observations of waterfowl and other wildlife were recorded from vantage points along public roads; the best vantage point was along the west side of Upper Lake. Observations were made through a spotting scope and/or binoculars.

Species lists by habitat were derived from nonsystematic "walk-through" reconnaissances of habitats on Asarco's property around Upper Lake. Species were recorded either from actual sightings, or from observations of evidence (tracks, hair, feathers, scats, skeletal remains, etc.).

Wetlands were identified from Cowardin et al. (1979). Wetlands and upland habitats within a total study area of about 176 acres were mapped at a scale of 1" = 400′.

Other ponds in the Prickly Pear Creek drainage between the East Helena plant and Interstate Highway 91 were located by examining aerial photographs at the Montana Department of Highways, followed by site visits. Wildlife uses were recorded, and qualitative assessments were made of the similarity of these sites to Upper Lake.

3.0 RESULTS AND DISCUSSION

3.1 WETLAND AND UPLAND HABITATS

Habitats in the Upper Lake vicinity were mapped in Figure 1 and tabulated in Table 1. Boundaries between wetland habitats may not be entirely accurate, due to the difficulty of estimating a wetland type's size and shape. In addition, some of the wetland type designations were based on water regimes (Cowardin et al., 1979) during early spring, before runoff subsided; if these regimes changed during drier seasons, wetland definitions and boundaries might change.

Cowardin et al.'s (1979) wetland classification scheme is based upon an hierarchy beginning with the most general of categories (i.e., System) and becoming increasingly specific. This hierarchy is: System, Subsystem (if applicable), Class (based on substrate material, flooding regime or vegetative life forms), Subclass (usually based on finer differences in life forms), Dominance Type (usually based on the dominant plant or animal form), and modifying terms (Water Regime, Water Chemistry and Special Modifiers). Thus, a specific wetland may have an hierarchy consisting of 8-9 terms.

3.1.1 Wetland types

Two wetlands systems are present in the Upper Lake area: riverine and palustrine (Cowardin et al., 1979). The riverine wetland is associated with Prickly Pear Creek, while palustrine wetlands are a result of the diversion of Prickly Pear Creek into Upper Lake. For mapping purposes, these wetlands were given alphabet designations (i.e., A, B, C and D).

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Fig. 1. Wildlife habitats in the Upper Lake wildlife reconnaissance area.

Table 1. Acreages of habitats within the Upper Lake wildlife reconnaissance area.

Habitat	Approx. Acreage
Wetland A	7
Wetland B	32
Wetland C	5
Wetland D	15
Open water	24
Grassland	27
Pasture	30
Mesic shrub	1
Cropland	19
Disturbed	16
Total	176

3.1.1.1 Wetland type A

This wetland comprised the riverine system associated with Prickly Pear Creek. Its classification, according to criteria presented in Cowardin et al. (1979) was:

System: Riverine
- Subsystem: Upper Perennial
  - Class: Unconsolidated shore
    - Subclass: Cobble-gravel
      - Water regime: Permanently flooded
        - Water chemistry: Fresh
          - Special modifier: Dam

Wetland type A was composed of the narrow band of habitat along Prickly Pear Creek (Figure 1). In general, it was bounded to the east by upland habitats and to the west by other wetland habitats. The substrate of Prickly Pear Creek was boulder/cobble/gravel with no emergent aquatic vegetation. The stream was a typical riffle/run sequence in this reach, with gradients (measured with a clinometer) varying between 1-4 percent, depending on microsite conditions. The shoreline consisted of exposed substrate during low-flow periods, while during high flows, water flooded adjoining upland habitats (small patches of mesic shrubs mixed with native and introduced grasses) as well as wetland habitats. The special modifier associated with this type was the diversion dam for Upper Lake, which created a small pool above the dam.

3.1.1.2 Wetland type B

Wetland type B was the largest of the palustrine wetlands (Figure 1). Its classification (Cowardin et al., 1979) was:

System: Palustrine
- Class: Scrub-shrub wetland
  - Subclass: Broad-leaved deciduous; dead
    - Dominance type: *Salix* spp.
      - Water regime: Semipermanent flooded
        - Water class: Fresh
          - Special modifier: Impoundment

Two subclasses were present: broad-leaved deciduous shrub, and dead. These distinctions were made on the basis of willow/alder stands that were either alive or dead; dead shrubs had apparently been killed by persistent immersion in the water of Upper Lake. In early spring the soils in this type varied from exposed but saturated, to submersed. Soils appeared to be primarily loam and sediment, mixed with exposed gravel. At drier sites, mesic upland grasses such as Kentucky bluegrass (Poa pratensis), brome (Bromus spp.) and ryegrass (Elymus spp.) were present. On wetter sites, these were replaced with common reed (Phragmites communis) and cattail (Typha spp.). Some sites supported little or no understory vegetation.

3.1.1.3 Wetland type C

This wetland was composed of cattail stands along the edge of open water in Upper Lake. Its classification (Cowardin et al., 1979) was:

System: Palustrine
Class: Emergent wetland
Subclass: Persistent
Dominance type: Typha spp.
Water regime: Permanently flooded
Water Chemistry: Fresh
Special modifier: Impoundment

During early spring, 1989 the cattail stands in Upper Lake were all flooded, and it was assumed that these stands would be permanently flooded throughout the year. The bottom substrate in this type appeared to be entirely sediment.

3.1.1.4 Wetland type D

The last wetland type recognized in the Upper Lake area was comprised of forested stands at the upstream end of the lake. It was classified (Cowardin et al., 1979) as:

System: Palustrine
Class: Forested wetland
Subclass: Broad-leaved deciduous
Dominance type: Cottonwood/aspen
Water regime: Intermittently flooded
Water chemistry: Fresh

According to Cowardin et al., 1979), most broad-leaved deciduous forested wetlands are found in the southern and eastern United States. Therefore, the dominance type for the Upper Lake classification was extrapolated from existing vegetation at the site, rather than from dominance types listed in Cowardin et al. (1979). The dominant trees were aspen (Populus tremuloides) and cottonwood (Populus deltoides), and the understory varied from mesic shrubs and grasses such as rose (Rosa spp.) and Kentucky bluegrass, to standing water.

In spring, 1989 part of wetland type D was flooded, but the remainder was not and perhaps may never flood. In the intermittently flooded water regime (Cowardin et al., 1979), "...weeks, months or even years may intervene between periods of inundation..." and "...some areas exhibiting this regime do not fall within our definition of wetland because they do not have hydric soils or support hydrophytes." Parts of the stand mapped as wetland type D at Upper Lake may not actually be a wetland under this definition, but the difference in sites was too small to differentiate in Figure 1.

3.1.1.5 Open water

These areas (Upper Lake, bounded by upland and other wetland types; and Lower Lake, bounded by essentially disturbed sites consisting of dikes/roads, etc.) did not readily fit Cowardin et al.'s (1979) definitions of either lacustrine or palustrine, and were therefore mapped as open water (Figure 1). However, these impoundments most closely fit the definition assigned to the palustrine system. Upper Lake's class was either unconsolidated bottom (subclass mud) or aquatic bed (subclass rooted vascular). Lower Lake's class was not determined but was assumed to be unconsolidated bottom (subclass probably mud).

3.1.2 Upland habitats

Upland habitats were used primarily to define the limits of wetland types. Consequently their mapping units were not closed (Figure 1), and there was no examination of the relationship of upland habitats along the lake to surrounding areas.

3.1.2.1. Grassland

Grassland habitat was present along the edges of almost all wetland and other upland habitats, but was too small to map. Larger blocks of grassland were mapped on both sides of Upper Lake (Figure 1). This habitat consisted of native grassland stands (including species such as blue grama, _Bouteloua gracilis_; needle-and-thread, _Stipa comata_; and bluebunch wheatgrass, _Agropyron spicatum_) that were invaded by introduced species including Kentucky bluegrass, wheatgrasses (_Agropyron_ spp.), and cheatgrass (_Bromus tectorum_). Some of these sites were disturbed in the past and have incompletely revegetated. The forb component varied greatly from site to site. In terms of ecological function, this habitat was similar to shortgrass prairie common to the Helena Valley.

3.1.2.2. Pasture

Pasture habitat was mapped in the southeast corner of the study area (Figure 1). It was differentiated from grassland in Figure 1 because it was grazed; cattle were present throughout the wildlife reconnaissance period. The vegetation species in this type were not examined closely but appeared to be introduced wheatgrasses (Agropyron spp.) mixed with bluegrasses (Poa spp.). During the time frame of the wildlife reconnaissance, these grasses were never more than 3-4 inches high and there was no residual grass cover.

3.1.2.3 Mesic shrub

Mesic shrub habitat was generally limited to wetland edges and small ephemeral drainages to Upper Lake. In most places, this habitat was too small to be mapped but there was a well developed, narrow stand along the west edge of Upper Lake (Figure 1). Major species were rose (Rosa spp.), currant (Ribes spp.)and snowberry (Symphoricarpos occidentalis).

3.1.2.4. Crop

There were winter wheat fields in the southwest corner, as well as along the west boundary, of the study area. These sites provided little cover for wildlife but were used as feeding habitats by wildlife species that occupied other habitats around Upper Lake.

3.1.2.5 Disturbed

Disturbed habitats were mapped around Lower Lake, along the railroad grade through Upper Lake, and in the northeast corner of the study area (Figure 1). There were other disturbed sites throughout the study area that were too small to be mapped. Some disturbed sites, such as the railroad grade, had substantial amounts of vegetation while other sites were essentially bare.

3.2 WILDLIFE USE OF HABITATS

3.2.1 Species lists

No amphibians, one reptile, 20 mammals and 58-61 species of birds were recorded in the 176-acre Upper Lake wildlife reconnaissance area during spring, 1989 (Table 2). The total of 79-82 species was subjectively considered quite good, since the study area was so small, was not quantitatively sampled, and was visited on only seven occasions between March 15 and June 2. This good species diversity was attributed to habitat diversity; there were 10 distinct habitats within a comparatively small area (Figure 1).

In comparison, latilong 28 (an area bounded by one degree of latitude and one degree of longitude) encompasses the Upper Lake wildlife reconnaissance area but is approximately 3000 square miles in size.

About 266 species of birds, 59 mammals, eight reptiles and five amphibians have been recorded within latilong 28 (Thompson, 1982; Skaar et al., 1985). Thus, about 22-23 percent of the birds, 34 percent of the mammals, 13 percent of the reptiles and none of the amphibians that potentially occur in the surrounding region were recorded in the Upper Lake study area. In total, about 24 percent of all species recorded in the surrounding 3,000 square miles were observed within the 176-acre Upper Lake wildlife reconnaissance area during spring, 1989.

Furthermore, the Upper Lake area species diversity was undoubtedly greater than 79-82 species. For example, there were probably amphibians in the study area. There were undoubtedly many more species of small mammals (including

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Table 2. Wildlife species recorded by habitat, Upper Lake wildlife reconnaissance, spring, 1989.

Species	Habitats: Wetland A	Wetland B	Wetland C	Wetland D	Open water	Grassland	Pasture	Mesic shrub	Crop	Dist.
AMPHIBIANS										
None										
REPTILES										
Garter snake (*Thamnophis* prob. *elegans*)	X					X				
MAMMALS										
Masked shrew (*Sorex cinereus*)				X						
Nuttall's cottontail (*Sylvilagus nuttallii*)		X		X		X		X		
White-tailed jackrabbit (*Lepus townsendii*)						X			X	X
Yellow-pine chipmunk (*Eutamias* prob. *amoenus*)				X				X		X
Columbian ground squirrel (*Spermophilus richardsonii*)						X	X			
Red squirrel (*Tamiasciurus hudsonicus*)				X						
Northern pocket gopher (*Thomomys talpoides*)						X	X		X	X
Beaver (*Castor canadensis*)	X	X		X	X					
Deer mouse (*Peromyscus maniculatus*)	X	X		X		X		X	X	X
Vole (*Microtus* spp.)	X	X		X				X		
Western jumping mouse (*Zapus princeps*)						X				
Porcupine (*Erithizon dorsatum*)				X				X		
Coyote (*Canis latrans*)						X			X	
Red fox (*Vulpes vulpes*)	X	X	X	X		X		X	X	X
Raccoon (*Procyon lotor*)	X	X	X	X				X		
Mink (*Mustela vison*)	X	X	X		X			X		
Badger (*Taxidea taxus*)						X				
Striped skunk (*Mephitis mephitis*)								X		
White-tailed deer (*Odocoileus virginianus*)	X	X		X		X			X	X
Pronghorn (*Antilocapra americana*)									X	

Table 2 (continued).

Species	Habitats									
	Wetland A	Wetland B	Wetland C	Wetland D	Open water	Grassland	Pasture	Mesic shrub	Crop	Dist.
BIRDS										
Pied-billed grebe (*Podilymbus podiceps*)					X					
Great blue heron (*Ardea herodius*)	X		X		X					
Canada goose (*Branta canadensis*)[a]		X	X		X			X		
Mallard (*Anas platyrhynchos*)[a]		X	X		X					
Blue-winged teal (*Anas discors*)					X					
Gadwall (*Anas strepera*)[a]		X			X					
American wigeon (*Anas americana*)		X			X					
Redhead (*Aythya americana*)					X					
Lesser scaup (*Aythya affinis*)					X					
Common goldeneye (*Bucephala clangula*)					X					
Barrow's goldeneye (*Bucephala islandica*)					X					
Common merganser (*Mergus merganser*)[a]					X					
American kestrel (*Falco sparverius*)				X		X			X	
Gray partridge (*Perdix perdix*) (?)						X				
Killdeer (*Charadrius vociferus*)[a]						X	X		X	X
Unident. sandpiper (*Calidris* spp.)	X	X	X							X
Common snipe (*Gallinago gallinago*)[a]	X	X					X			
Franklin's gull (*Larus pipixcan*)			X		X					
Gull (*Larus* spp., prob. ring-billed gull, California gull and/or herring gull)			X		X					
Rock dove (*Columba livia*)										X
Mourning dove (*Zenaida macroura*)						X	X			X
Great horned owl (*Bubo virginianus*)[a]				X						
Belted kingfisher (*Ceryle alcyon*)	X	X			X					
Northern flicker (*Colaptes auratus*)[a]				X						
Unident. flycatcher (*Empidonax* spp., prob. Hammond's or Dusky flycatcher)				X						
Horned lark (*Eremophila alpestris*)[a]						X	X		X	X
Barn swallow (*Hirundo rustica*)					X					
Black-billed magpie (*Pica pica*)[a]	X	X		X						
American crow (*Corvus brachyrhynchos*)									X	
Common raven (*Corvus corax*)				X						X
Mountain chickadee (*Parus gambeli*)	X			X						
American dipper (*Cinclus mexicanus*)	X									
Golden-crowned kinglet (*Regulus satrapa*)				X						
Mountain bluebird (*Sialia currucoides*)[a]						X	X	X	X	X
Townsend's solitaire (*Myadestes townsendi*)	X									
Veery (*Catharus fuscescens*)[a]				X						
American robin (*Turdus migratorius*)[a]				X						
Bohemian waxwing (*Bombycilla garrulus*)	X	X		X						

Table 2 (continued).

Species	Habitats									
	Wetland A	Wetland B	Wetland C	Wetland D	Open water	Grassland	Pasture	Mesic shrub	Crop	Dist.
Loggerhead shrike (*Lanius ludovicianus*)									X	
European starling (*Sturnus vulgaris*)						X				X
Warbling vireo (*Vireo gilvus*)[a]	X	X		X						
Orange-crowned warbler (*Vermivora celata*)	X			X						
Yellow warbler (*Dendroica petechia*)[a]	X	X		X						
American redstart (*Setophaga ruticilla*)				X						
Wilson's warbler (*Wilsonia pusilla*)[a]	X	X		X						
Lazuli bunting (*Passerina amoena*)	X			X						
American tree sparrow (*Spizella arborea*)	X	X								
Chipping sparrow (*Spizella passerina*)				X						
Vesper sparrow (*Pooecetes gramineus*)[a]						X	X	X	X	X
Song sparrow (*Melospiza melodia*)	X									
Snow bunting (*Plectrophenax nivalis*)									X	
Red-winged blackbird (*Agelaius phoeniceus*)[a]		X	X					X		
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)[a]		X	X							
Western meadowlark (*Sturnella neglecta*)[a]				X		X	X		X	X
Brown-headed cowbird (*Molothrus ater*)								X	X	
Northern oriole (*Icterus galbula*)[a]		X		X						
Pine siskin (*Carduelis pinus*)		X								
House sparrow (*Passer domesticus*)						X				X

[a]Hard or circumstantial evidence of breeding

bats) than were recorded, but these could not be readily documented without some form of trapping program. Similarly, there were probably many more species of small passerine birds in the shrub/tree habitats of the study area, but these would not have been easily documented without more systematic study.

In summary, the Upper Lake wildlife reconnaissance area provides an excellent combination and diversity of habitats in a small area. This diversity is reflected in the comparatively large number of species recorded by qualitative sampling.

3.2.2 Species diversity by habitat

Twenty-four wildlife species were recorded in wetland type A, compared to 25 species in wetland type B, 11 species in wetland type C, 31 species in wetland type D, and 18 species in open water. Among the upland habitats, 21 species were recorded in grassland habitat, compared to nine species in pasture, 14 species in mesic shrub, and 17 species each in cropland and disturbance habitats (Table 2).

Not surprisingly, wetland type D with its complexity of vertical habitat structure (trees, shrubs, herbaceous understory) and edge with seven other habitats (Figure 1) provided the largest number of species; half of these were mammals. Wetland types A and B shared many species, and their totals were nearly identical. Open water contributed 18 species, primarily through use by migrating waterfowl. Wetland C, with its small area, short vertical structure (cattails) and submersed substrate, provided only 11 species, the second lowest total of all habitats.

Among upland habitats, grassland contributed the largest number of species (21) but fewer than half of these were birds, in contrast to most wetland habitats (Table 2). Pasture habitat contributed very few species, primarily due to its lack of cover. Cropland, disturbance and mesic shrub habitats all provided similar numbers of species.

Wetland habitats contained more structure and edge than upland habitats. This difference was accentuated by the number of wildlife species recorded in each category. Wetland habitats shared 58 total species, while upland habitats shared only 38 (Table 2). Thus, wetland wildlife species diversity was about 50 percent greater than that of uplands.

3.2.3 Species breeding within the Upper Lake area

Hard (nests with eggs, broods) or circumstantial (territorial or other breeding behavior) evidence of breeding was recorded for 20 species of birds within the Upper Lake wildlife reconnaissance area. This number was undoubtedly low, as many of the passerine species listed in Table 2 probably nested within the area. Similarly, many mammals listed in Table 2 for which there was no evidence of breeding undoubtedly reproduced within the study area boundaries. It is estimated that 43 of the 79-82 species (52-54 percent) of the species listed in Table 2 probably reproduced within the study area.

3.3 COMPARISON OF UPPER LAKE WITH OTHER PONDS ON PRICKLY PEAR CREEK

Ponds at two other locations on Prickly Pear Creek between Upper Lake and Interstate Highway 15 were examined during this reconnaissance. The largest of these was in the SE1/4 SE1/4 S14, T9S R3W. However, it was only an estimated three acres in size, much smaller than Upper Lake. Unlike Upper Lake, this pond was apparently made by gold dredging machinery, and the bottom substrate (qualitatively examined by wading a short distance into the pond) seemed to have less sediment and more boulders/cobbles than Upper Lake. Its shoreline and surrounding areas were similar to wetland type A. It did not have mappable stands of wetland types B (partially flooded willow/alder stand), C (emergent herbaceous vegetation) or D (trees). The nearest grassland was several hundred feet away, and was interrupted by an access road to a nearby residence.

Wildlife species recorded at this site were similar to those recorded for wetland type A (Table 2). There was very little waterfowl use of this site, although mallards, blue-winged teal and great blue herons were observed landing at this pond for short periods. Furthermore, in early March this site still contained considerable amounts of deep snow, and there was little evidence of white-tailed deer use of this area. In comparison, on March 24 a total of 49 white-tailed deer were seen in the upland habitats surrounding Upper Lake. All these deer eventually moved to wetland habitats D and B. It should be noted that while the Upper Lake area undoubtedly supports some white-tailed deer yearlong, many of the deer seen on March 24 were believed to have moved downstream to the lower elevation, more open habitats/feeding sites, and lower accumulation of snow at Upper Lake than were present further upstream in the Prickly Pear Creek drainage.

Another difference between Upper Lake and the pond in section 14 was the amount of use by humans and domestic dogs. Tracks in the snow indicated that, despite the fact that it is fenced and posted, a few people still walked through the Upper Lake area, particularly in wetland type D. Domestic dog tacks were also observed in wetland types A and D. Nevertheless, this use was low compared to use of the pond in section 14, which was near an occupied residence. Dog tracks were so abundant around this pond's edge that some displacement/harassment of wildlife must have occurred. Similarly, human tracks (both adults and children) were present along the shoreline near the residence.

There were two very small ponds (also formed by dredging operations) along Prickly Pear Creek in the NW1/4 SW1/4 S13, T9S R3W, approximately due south of the Montana City school. These ponds were on opposite sides of the creek from each other, and neither was estimated to be larger than 1/2-acre. Both were visited during spring runoff, when wetland type A along the shoreline was flooded. Neither were considered comparable to Upper Lake, either in terms of habitat or wildlife use.

A third site, the Northern Pacific Reservoir on McClellan Creek about 1/4-mile above its confluence with Prickly Pear Creek, was also briefly examined. This site was similar in size to Upper Lake but was bounded by open upland habitats on the north and east sides, and did not contain the wetland habitat development of Upper Lake. There were buildings and a road overlooking the reservoir, and this activity may have reduced wildlife use of the reservoir. Nevertheless, mallards, lesser scaup, Canada geese, common mergansers and great blue herons were observed at this site, even though this use was never as consistent or prolonged as the use of Upper Lake.

In summary, there were no other ponds or impoundments in the next four miles of Prickly Pear Creek upstream from Upper Lake that even remotely resemble Upper Lake in terms of habitat diversity and availability, as well as wildlife use.

3.4 USE BY ENDANGERED OR THREATENED SPECIES

According to USFWS (Appendix A), two species of Federally-listed endangered species that may potentially occur at or near Upper Lake are the bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus*). Neither was seen during the spring, 1989 wildlife reconnaissance of Upper Lake and Prickly Pear Creek upstream to Interstate Highway 15.

There are no known nest territories of either species in the immediate project area. Although there are occasional deciduous and coniferous trees in the Prickly Pear Creek drainage that could support an eagle nest, the abundance of human activity in the drainage (roads, homes, industrial sites, a school, recreational use, etc.) probably precludes nesting use of these trees. There are no cliffs or rock outcrops in or near the drainage suitable for nesting by peregrine falcons.

Both species would feasibly be attracted to Upper Lake by waterfowl and non-breeding gulls as prey. Although there are fish (trout) in Prickly Pear Creek (wetland type A) and apparently also in portions of Upper Lake, there does not appear to be a large enough supply of appropriately sized fish in the lake to attract and retain eagles.

From late autumn through early spring, when most bald eagles are present in the surrounding region, Upper Lake is frozen and provides very little open water for waterfowl. Waterfowl use is very limited during this period. At times when waterfowl are most common at Upper Lake (spring and autumn migration), they are far more abundant at other sites in the region, such as Lake Helena, Canyon Ferry Reservoir and the Missouri River; these waters also contain a suitable fish prey base for bald eagles. For example, 50 ducks and geese and 41 gulls were counted at Upper Lake on the morning of April 19, 1989. This number undoubtedly was a small fraction of the numbers of these two groups that were present at Lake Helena on the same date.

In conclusion, although both bald eagles and peregrine falcons could occasionally hunt waterfowl and gulls at Upper Lake (most likely during migration periods), the lake does not support and maintain a large enough prey base to attract and maintain either raptor, nor are there suitable nest sites for either species in the vicinity. Therefore, occurrence of either species at Upper Lake is probably rare and accidental.

4.0 SUMMARY

Wildlife resources and habitats in the Upper Lake vicinity were qualitatively examined through seven site visits from mid-march to early June, 1989. The Upper Lake area, while comparatively small, provides a diverse mixture of habitats comprised of a variety of vertical structures and edge. In total, five wetland habitats and five upland habitats were recognized and mapped within approximately 176 acres of study area. Because human use of the study area is restricted by Asarco, most of these habitats (and the wildlife that use them) are little affected by human activities, particularly in comparison to the rest of the Prickly Pear Creek drainage.

In response to its habitat diversity, the Upper Lake site supports a good diversity of wildlife species. Qualitative reconnaissance observations yielded 79-82 species of birds, mammals and reptiles, or about 24 percent of the total number of species reported in the literature from the surrounding 3,000 mi^2 latilong. Quantitative methods and more intense surveys would undoubtedly have provided an even larger number of species.

Based on qualitative observations, wetland habitats that provided a mixture of vertical habitat structure (tress and shrubs) with wet sites supported more species than any other habitats. Wetlands generally supported more species than uplands. Wetlands supported a greater diversity of birds than uplands. As expected, upland habitats contributed a greater diversity of mammals than wetlands.

There were no sightings of Federally-listed endangered or threatened species during the reconnaissance period. Upper Lake did not contain a persistent prey base or suitable nest sites for either bald eagles or peregrine falcons, the two endangered species most likely to occur at the site.

There were no other ponds or impoundments in the Prickly Pear Creek drainage from Upper Lake to Interstate Highway 15 that were similar in habitat composition or wildlife use. The nearest similar habitat is probably at Lake Helena, about seven miles north.

5.0 LITERATURE CITED

Cowardin, L.M., V. Carter, F.C. Golet and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S.D.I. Fish and Wildl. Serv. FWS/OBS-79/31.

Skaar, D., D. Flath and L.S. Thompson. 1985. P.D. Skaar's Montana bird distribution. Montana Acad. Sci. Mono. No. 3.

Thompson, L.S. 1982. Distribution of Montana amphibians, reptiles and mammals. Montana Audubon Council, Helena.

Appendix A.

Letter from the U.S. Fish and Wildlife Service
regarding endangered or threatened wildlife
species at Upper Lake

0211197

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Fish and Wildlife Enhancement
Federal Bldg., U.S. Courthouse
301 South Park
P.O. Box 10023
Helena, Montana 59626

IN REPLY REFER TO:

10111-East Helena

March 21, 1989

Mr. Patrick Farmer
Western Technology and Engineering Inc.
P.O. Box 6045
3005 Airport Road
Helena, Montana 59604

Dear Mr. Farmer:

We have received your letter dated March 14, 1989, in which you requested a list of federally-listed endangered species that may occur in the general vicinity of the ASARCO Incorporated East Helena Plant Superfund Site in East Helena, Montana. It is our understanding that your firm, in conjunction with ASARCO Incorporated and the U.S. Environmental Protection Agency, is participating in the performance of a comprehensive site investigation and feasibility study to evaluate possible site-specific remedial contaminant cleanup alternatives for the East Helena Superfund Site.

The eventual decision by the U.S. Environmental Protection Agency on implementation of a remedial cleanup action identified in the feasibility study will constitute a Federal action and will require compliance with the Endangered Species Act. Section 7(a)(2) of the Endangered Species Act of 1973 (P.L. 93205), as amended, requires that all Federal agencies in consultation with the U.S. Fish and Wildlife Service shall insure that any action authorized, funded or carried out by such agency is not likely to jeopardize the continued existence of any threatened or endangered species. The federally-listed endangered species that occur or may occur within the project area are the bald eagle (Haliaeetus leucocephalus) and the peregrine falcon (Falco peregrinus). There are no known bald eagle or peregrine falcon nest territories in the immediate project area. If the remedial cleanup action proposed by the U.S. Environmental Protection Agency will adversely affect these listed species, then formal consultation with the U.S. Fish and Wildlife Service is required.

In your identification and inventory of wetland habitat resources associated with the ASARCO site, we recommend that every effort be made to identify any potential cleanup associated wetland impacts and that unavoidable impacts to wetlands be mitigated or offset during the remedial action planning and implementation process.

0211198

We appreciate your efforts to consider and conserve endangered species and their habitats, as well as other wildlife resources. If you have any questions regarding this letter, please contact Don Palawski of my staff at (406) 449-5225.

Sincerely,

Kemper M. McMaster
Acting State Supervisor
Montana State Office

cc: ARD, USFWS, Denver, CO (FWE-60153) Attention: Tom Jackson
Bob Stewart, DOI, OEPR, Denver, CO
Scott Brown, Environmental Protection Agency, Helena, MT

DUP/dup

APPENDIX 6-1

SUMMARY OF SLAG ANALYSES FOR TEST BASIN WATER QUALITY, BOTTLE ROLL TESTS AND EP TOXICITY TESTS

0211200

OF SLAG WATER QUALITY ANALYSES - ASARCO EAST HELENA

SITE NAME	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG
SAMPLE DATE	12/30/86	04/02/87	04/22/87	04/22/87	05/22/87	05/22/87	05/22/87	05/22/87	07/15/87	07/15/87
LAB	ASARCO	ASARCO	ASARCO	CHMTC	ASARCO	ASARCO	CHMTC	CHMTC	ASARCO	ASARCO
REMARKS	BOTTLE			SPLIT	REPLICATE		SPLIT	REPLICATE	REPLICATE	
REMARKS	ROLL TEST									
SAMPLE NUMBER		8704-1	8704-20		8705-50	8705-47			8707-02	8707-01
PHYSICAL PARAMETERS										
WATER TEMPERATURE (C)			7.5			9.7				
SPEC. COND. (UMHOS/CM) FIELD			2235		2268	2265			2137	2150
SPEC. COND. (UMHOS/CM) LAB	115	1950	2250			2320				2400
PH FIELD			6.16 *		7.48	7.69				7.46
PH LAB	9.9	7.77	6.81			7.52				7.55
TDS MEAS. @ 180 DEG. C	94	1842	1903 *	993		2086	2227			1912 *
OXYGEN (O) DISS			4.3			4.3				4.1
DEPTH TO SWL BELOW MP (FT)			8.74 *			8.01				
COMMON IONS										
CALCIUM (CA)	12	510	454	449.0		422	417.0	412.0		321
MAGNESIUM (MG)	0.49	20	25.5	27.40		20.2	25.10	24.90		22.9
SODIUM (NA)	5.1	76	71.5	76.6		85	72.5	71.8		74
POTASSIUM (K)	3.9	54	65	60.80		74	136.00	122.00		68
BICARBONATE (HCO3) (LAB)	<1.0	260 *	102			98				84
CARBONATE AS CO3 (LAB)	19	<1	<1			<1				<1.0
SULFATE (SO4)	10	1450	1425	1240.0		1338	1304.0			1200
CHLORIDE (CL)	18	6.0	7.0	10.0		7.0	30.0			4.0
TRACE ELEMENTS										
ARSENIC (AS) DISS	0.19	0.0325	0.0283	0.0198	0.038	0.030	0.0530	0.0320	0.057 *	0.039 *
ARSENIC (AS) +3			0.014						0.0216	0.060 *
ARSENIC (AS) +5			0.010						0.0722 *	0.0268
CADMIUM (CD) DISS	0.003	0.075	0.060	0.0720	0.051	0.051	0.0520	0.0500	0.055	0.049
COPPER (CU) DISS	0.008	0.280 *	0.193	0.2260	0.125	0.128	0.1480	0.1340	0.118	0.110
IRON (FE) DISS	0.11	<0.020	<0.020	<0.100	0.044	0.045	<0.100	<0.100	<0.020	<0.020
IRON (FE II)			0.010 *						0.060	0.080
LEAD (PB) DISS	<0.017	0.045 *	0.030 *	0.0334	0.019	0.020	0.0323	0.0432	0.016	0.021
MANGANESE (MN) DISS	<0.017	1.080	1.440	2.640	1.910	1.930	2.660	2.640	2.930	2.890
ZINC (ZN) DISS	0.023	3.580	3.700	4.450	2.830	2.890	2.860	2.820	2.500	2.300

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 03-19-1989
HWQ-6/86-R1

0211201

SUMMARY OF SLAG WATER QUALITY ANALYSES - ASARCO EAST HELENA

SITE NAME	FUMED SLAG	FUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG
SAMPLE DATE	09/22/87	09/22/87	12/30/86	04/22/87	04/22/87	05/22/87	05/22/87	07/15/87	09/22/87
LAB	ASARCO	ASARCO	ASARCO	ASARCO	CHMTC	CHMTC	ASARCO	ASARCO	ASARCO
REMARKS	REPLICATE		BOTTLE		SPLIT	SPLIT			
REMARKS			ROLL TEST						
SAMPLE NUMBER	8709-06	8709-04		8704-24			8705-48	8707-03	8709-07
PHYSICAL PARAMETERS									
WATER TEMPERATURE (C)		16 *		10.5			10.9		17 *
SPEC. COND. (UMHOS/CM) FIELD	1368	1366		16296 *			19978	19850	
SPEC. COND. (UMHOS/CM) LAB		1350	200	16500			20200	22000	12200
PH FIELD				9.49			9.97 *	9.48	
PH LAB		7.63	10.4	9.25			9.6	9.73	9.69
TDS MEAS. @ 180 DEG. C		1114	206	14183 *	7298	18720	18523	18172 *	10984
OXYGEN (O) DISS		4.0		4.5			3.2	3.0	4.1
DEPTH TO SWL BELOW MP (FT)		7.74		8.83			7.85		7.02
COMMON IONS									
CALCIUM (CA)		126.5	17	371	437.0		361	426	345
MAGNESIUM (MG)		11	0.22	8.5	8.76		6.7	6.4	4.2
SODIUM (NA)		45	19	2900	2960.0		3890	3800	2200
POTASSIUM (K)		65	22	1950	158.00		2650	2550	1540
ALKALINITY AS CACO3 (LAB)							587		
BICARBONATE (HCO3) (LAB)		72	<1.0	486 *			<1	<1.0	<1.0
CARBONATE AS CO3 (LAB)		<1.0	36	<1			284	163	197
HYDROXIDE (OH)							38	46	30
SULFATE (SO4)		480 *	16	9200	2480.0	2463.0	1200	11750	6750
CHLORIDE (CL)		3.0	16	57	63.0	75.0	66	74	35
TRACE ELEMENTS									
ARSENIC (AS) DISS	0.075 *	0.054 *	0.31	0.620	0.5130		0.353	0.590 *	0.553
ARSENIC (AS) +3				0.400				0.550	
ARSENIC (AS) +5				0.030				0.054	
CADMIUM (CD) DISS	0.021	0.021	0.003	0.030 *	0.0063		0.003	0.005	0.003
COPPER (CU) DISS	0.055	0.056	0.008	0.130	0.1190		0.128	0.085	0.043
IRON (FE) DISS	<0.020	<0.020	0.070	0.150	<0.100		0.225 *	<0.020	<0.020
IRON (FE II)	0.02	<0.01		<0.010				0.070	<0.01
LEAD (PB) DISS	0.023	0.026	0.083	0.098 *	0.1430		0.0505	0.021 *	0.094
MANGANESE (MN) DISS	1.590	1.540	<0.017	0.155 *	0.139		0.083	0.090	0.050
ZINC (ZN) DISS	0.813	0.788 *	0.053	0.100 *	0.090		0.048	0.030	0.023

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 03-19-1989
HWQ-6/86-R1

TABLE 1
East Helena

SLAG SAMPLE LEACHATE ANALYSIS

1979

979 SARCO ab No.	Description	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	(Zn)
		(PPM in Leachate)								
3278	Slag 1 Zn	.018	.3	.08	<.01	.6	<.001	<.005	<.01	3.5
3279	Slag 2 Zn	<.014	.1	.13	<.01	<.1	<.001	<.005	<.01	2.6
3280	Slag 3 Zn	.020	.1	.03	<.01	3.4	<.001	<.005	<.01	2.1
3281	Slag 4 Zn	<.014	.2	<.01	<.01	<.1	<.001	<.005	<.01	1.0
3282	Slag 5 Pb	.032	.2	<.01	<.01	3.3	<.001	<.005	<.01	5.0
[illegible]3	Slag 6 Pb	<.014	.1	.15	<.01	1.0	<.001	<.005	<.01	6.0
aximum Contaminant evels for Non-oxic Leachates		0.5	10.0	0.1	0.5	0.5	.02	0.1	0.5	---*

NOTE →

old limits

* Currently unspecified but estimated to be 50 ppm (10 times the Drinking Water Standard).

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	As ppm	Cd ppm	Pb ppm
3658	Air Cooled Blast Furnace Slag	5/ 7	.12	.002	5.3
3659	Granulated Blast Furnace Slag	5/ 7	.047	<.002	.050

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Ag ppm	As ppm	Ba ppm	Cd ppm	Cr ppm
7860	TCLP-Fumed Blast Furnace Slag	10/21	<.002	.45	4.6	.007	.016
7861	TCLP-Unfumed Blast Furnace Slag	10/21	<.002	1.2	1.6	.25	.016

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Hg ppb	Pb ppm	Se ppm
7860	TCLP-Fumed Blast Furnace Slag	10/21	<.005	.28	.004
7861	TCLP-Unfumed Blast Furnace Slag	10/21	<.001	10.	.010

0211205

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Ag ppm	As ppm	Ba ppm	Cd ppm	Cr ppm
6378	Air Cooled Slag	8/15	<.005	.012	<1.0	.002	<.17
6379	Granulated Slag	8/15	<.005	.010	<1.0	<.002	<.17

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Hg ppb	Pb ppm	Se ppm	pH
6378	Air Cooled Slag	8/15	<.50	1.1	<.080	9.2
6379	Granulated Slag	8/15	<.50	.050	<.080	8.0

0211206

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1983 SAMPLE DATE	Pb ppm	Cd ppm	Cr ppm	Ag ppm	Ba ppm
11370 2-4 mo. old	Slag Composite	11/28	9.8	3.9	<.030	<.008	7.2
11371 1 week old	Slag Composite	11/28	3.9	<.004	<.030	<.008	8.7

ASARCO LAB #	SAMPLE DESCRIPTION	1983 SAMPLE DATE	As ppm	Se ppm	Hg ppb	pH
11370 2-4 mo. old	Slag Composite	11/28	.20	.012	<.50	10.
11371 1 week old	Slag Compcsite	11/28	.35	<.004	<.50	10.

	ppm							
	Ba	Pb	Cd	Cr	Ag	Se	Hg	As
Maximum allowable levels of contaminants in the leachate of a non-toxic material.....	100.	5.0	1.0	5.0	5.0	1.0	.2	5.0

0211207

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1984 SAMPLE DATE	Ag ppm	As ppm	Ba ppm	Cd ppm	Cr ppm
10051 Site #1	Blast Furnace Slag	10/12	<.008	.098	<1.0	.010	<.030
10052 Site #2	Blast Furnace Slag	10/12	<.008	.026	<1.0	.018	<.030
10053 Site #3	Blast Furnace Slag	10/12	<.008	.038	1.0	.018	<.030
10054 Site #4	Blast Furnace Slag	10/12	<.008	.23	2.0	<.004	<.030

ASARCO LAB #	SAMPLE DESCRIPTION	1984 SAMPLE DATE	Hg ppb	Pb ppm	Se ppm	pH
10051 Site #1	Blast Furnace Slag	10/12	<.50	8.4	<.080	8.6
10052 Site #2	Blast Furnace Slag	10/12	<.50	3.7	<.080	9.2
10053 Site #3	Blast Furnace Slag	10/12	<.50	12.	<.080	9.1
10054 Site #4	Blast Furnace Slag	10/12	<.50	30.	<.080	10.

	ppm in leachate							
	Ag	As	Ba	Cd	Cr	Hg	Pb	Se
Maximum allowable concentration of contaminant in the leachate of a non-toxic material................	5.	5.	100.	1.	5.	.2	5.	1.

SEP 04 '87 15:17 ASARCO SLC UT. 801 261-2194 P.6

0211208

APPENDIX 7-1

SUMMARY OF AIR QUALITY DATA

SUMMARY OF AIR FILTER QUALITY ANALYSES - ASARCO EAST HELENA

SITE NAME	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP
SAMPLE DATE	08/07/86	07/02/87	07/08/87	07/08/87	07/26/87	08/04/87	08/19/87	08/25/87	09/09/87	09/09/87
LAB	ASARCO	ASARCO	ASARCO	DHES	ASARCO	DHES	ASARCO	ASARCO	ASARCO	ASARCO
REMARKS				SPLIT		SPLIT				REPLICATE
SAMPLE NUMBER	89-1264	89-1265	89-1266	89-1266	89-1268		89-1269	89-1270	89-1272	89-1271
TRACE ELEMENTS										
ARSENIC (AS) TOTAL	0.34	0.19	0.59	0.515	0.20	0.638	0.70	0.010	0.57	0.51
BARIUM (BA) TOTAL	<0.07 J	<0.06 J	<0.06 J		<0.07 J	0.028	<0.06 J	<0.06 J	<0.06 J	<0.06 J
BERYLLIUM (BE) TOTAL	<0.003 J	<0.003 J	<0.003 J		<0.003 J	<0.0003	<0.003 J	<0.003 J	<0.003 J	<0.003 J
CADMIUM (CD) TOTAL	0.434 J	0.089 J	0.217 J	0.207	0.041 J	0.148	0.164 J	0.003 J	0.970 J	0.937 J
CHROMIUM (CR) TOTAL	<0.03 J	<0.03 J	<0.03 J		<0.03 J	<0.007	<0.03 J	<0.03 J	<0.03	<0.03 J
COPPER (CU) TOTAL				10.8		8.18				
IRON (FE) TOTAL	1.49 J*	1.44 J	1.73 J		1.21 J	2.34	1.92 J	0.29 J	1.96 J	1.72 J
LEAD (PB) TOTAL				3.98		4.41				
MANGANESE (MN) TOTAL	0.05 J	0.05 J	0.06 J		0.04 J	0.077	0.07 J	0.015 J	0.07 J	0.07 J
MERCURY (HG) TOTAL	0.007	0.004	0.009		0.005	0.0033	0.007	0.004	0.006	0.006
NICKEL (NI) TOTAL	<0.03 J	<0.03 J	<0.03 J		<0.03 J	0.007	<0.03 J	<0.03 J	<0.03 J	<0.03 J
SELENIUM (SE) TOTAL	<0.16 J	<0.15 J	<0.15 J		<0.17 J	<0.02	<0.16 J	<0.16 J	<0.16 J	<0.16 J
ZINC (ZN) TOTAL				1.40		1.83				

* Estimated Bias =-61%

SUMMARY OF AIR FILTER QUALITY ANALYSES - ASARCO EAST HELENA

0211210

SITE NAME	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP
SAMPLE DATE	09/18/87	09/27/87	10/09/87	10/21/87	10/30/87	11/05/87	11/14/87	11/14/87	11/26/87	12/02/87
LAB	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	DHES	ASARCO	ASARCO
REMARKS								SPLIT		
SAMPLE NUMBER	89-1274	89-1275	89-1277	89-1278	89-1279	89-1280	89-1281	89-1281	89-1282	89-1283
TRACE ELEMENTS										
ARSENIC (AS) TOTAL	0.15	0.017	0.065	0.17	0.97	0.61	0.065	0.071	0.27	0.14
BARIUM (BA) TOTAL	<0.06 J	<0.06 J	<0.06 J	<0.06 J	<0.06 J	<0.07 J	<0.06 J	0.023	<0.06 J	<0.06 J
BERYLLIUM (BE) TOTAL	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.0003	<0.003 J	<0.003 J
CADMIUM (CD) TOTAL	0.193 J	0.034 J	0.024 J	0.052 J	0.296 J	0.206 J	0.026 J	0.023	0.107 J	0.054 J
CHROMIUM (CR) TOTAL	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.006	<0.03 J	<0.03 J
COPPER (CU) TOTAL								0.96		
IRON (FE) TOTAL	1.16 J	0.36 J	0.96 J	2.03 J	3.96 J	2.87 J	1.47 J	1.60	0.90 J	1.34 J
LEAD (PB) TOTAL								0.97		
MANGANESE (MN) TOTAL	0.04 J	0.016 J	0.03 J	0.07 J	0.13 J	0.10 J	0.05 J	0.048	0.04 J	0.038 J
MERCURY (HG) TOTAL	0.006	<0.003	0.004	0.006	0.012	0.013	0.004	0.0016	0.006	0.004
NICKEL (NI) TOTAL	<0.03 J	<0.03 J	<0.03 J	<0.03 J	0.03 J	0.04 J	<0.03 J	<0.005	<0.03 J	<0.03 J
SELENIUM (SE) TOTAL	<0.15 J	<0.16 J	<0.15 J	<0.15 J	<0.14 J	<0.17 J	<0.16 J	<0.02	<0.15 J	<0.16 J
ZINC (ZN) TOTAL								0.41		

SUMMARY OF AIR FILTER QUALITY ANALYSES - ASARCO EAST HELENA

0211211

SITE NAME	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP
SAMPLE DATE	12/02/87	12/11/87	12/15/87	12/23/87	12/23/87	01/04/88	01/10/88	01/22/88	02/09/88	02/09/88
LAB	ASARCO	ASARCO	ASARCO	ASARCO	DHES	ASARCO	ASARCO	ASARCO	ASARCO	DHES
REMARKS	REPLICATE				SPLIT					SPLIT/DUP
SAMPLE NUMBER	89-1284	89-1285	89-1286	89-1287	89-1287	89-1288	89-1289	89-1290	89-1291	89-1291
TRACE ELEMENTS										
ARSENIC (AS) TOTAL	0.12	0.038	<0.003	0.45	0.521	0.99	0.15	0.31	0.013	0.023 J
BARIUM (BA) TOTAL	<0.06 J	<0.06 J	<0.06 J	<0.06 J	0.014	<0.05 J	<0.06 J	<0.06 J	<0.05 J	0.004
BERYLLIUM (BE) TOTAL	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.0003	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.0003
CADMIUM (CD) TOTAL	0.048 J	0.012 J	<0.003 J	1.69 J	1.499	2.68 J	0.045 J	0.105 J	0.005 J	0.009
CHROMIUM (CR) TOTAL	<0.03 J	<0.03 J	<0.03 J	<0.03 J	0.005	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.005
COPPER (CU) TOTAL					1.98					0.36
IRON (FE) TOTAL	1.24 J	0.96 J	0.03 J	0.97 J	0.88	2.35 J	0.70 J	2.00 J	0.18 J	0.18
LEAD (PB) TOTAL					5.89					0.19
MANGANESE (MN) TOTAL	0.033 J	0.02 J	<0.01 J	0.04 J	0.029 J	0.10 J	0.02 J	0.06 J	<0.01 J	0.005
MERCURY (HG) TOTAL	0.006	<0.003	<0.003	<0.003	0.0022	0.007	<0.003	0.005	<0.003	
NICKEL (NI) TOTAL	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.005	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.005
SELENIUM (SE) TOTAL	<0.14 J	<0.15 J	<0.14 J	<0.15 J	<0.02	<0.13 J	<0.14 J	<0.14 J	<0.14 J	<0.02
ZINC (ZN) TOTAL					4.06					0.06

SUMMARY OF AIR FILTER QUALITY ANALYSES - ASARCO EAST HELENA

0211212

SITE NAME	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP
SAMPLE DATE	02/09/88	02/12/88	02/27/88	03/04/88	03/06/88	03/28/88	03/28/88	04/06/88	04/15/88	04/15/88
LAB	DHES	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO
REMARKS	SPLIT					REPLICATE			REPLICATE	
SAMPLE NUMBER	89-1291	89-1292	89-1293	89-1294	89-1295	89-1297	89-1296	89-1298	89-1300	89-1299
TRACE ELEMENTS										
ARSENIC (AS) TOTAL	0.015	0.19	0.42	0.26	0.56	0.042	0.032	0.88	0.58	0.40 J
BARIUM (BA) TOTAL	0.004	<0.06 J	<0.06 J	<0.06 J	<0.06 J	<0.06 J	<0.06 J	<0.06 J	<0.06 J	<0.06 J
BERYLLIUM (BE) TOTAL	<0.0003	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.003 J	0.003 J
CADMIUM (CD) TOTAL	0.006	0.047 J	0.575 J	0.044 J	0.136 J	0.023 J	0.019 J	0.503 J	0.247 J	0.265 J
CHROMIUM (CR) TOTAL	<0.005	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J
COPPER (CU) TOTAL	0.32									
IRON (FE) TOTAL	0.18	1.09 J	1.58 J	0.55 J	1.37 J	0.15 J	0.24 J	3.79 J	2.05 J	2.25 J
LEAD (PB) TOTAL	0.17									
MANGANESE (MN) TOTAL	0.006	0.04 J	0.05 J	0.02 J	0.05 J	<0.01 J	<0.01 J	0.14 J	0.081 J	0.087 J
MERCURY (HG) TOTAL		<0.003	0.006	0.004	0.011	<0.003	<0.003	0.02	0.011	0.009
NICKEL (NI) TOTAL	<0.005	0.04 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J
SELENIUM (SE) TOTAL	<0.02	<0.15 J	<0.15 J	<0.15 J	<0.14 J	<0.14 J	<0.12 J	<0.14 J	<0.15 J	<0.15 J
ZINC (ZN) TOTAL	0.06									

SUMMARY OF AIR FILTER QUALITY ANALYSES - ASARCO EAST HELENA

0211213

SITE NAME	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP	FIRE HALL ST. STRIP
SAMPLE DATE	04/24/88	05/06/88	05/21/88	05/27/88	06/02/88	06/08/88	06/08/88	06/29/88
LAB	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	DHES	ASARCO
REMARKS							SPLIT	
SAMPLE NUMBER	89-1301	89-1302	89-1303	89-1304	89-1305	89-1306	89-1306	89-1307
TRACE ELEMENTS								
ARSENIC (AS) TOTAL	0.065	0.011	0.41	0.23	0.31	0.73	0.087 J	0.031
BARIUM (BA) TOTAL	<0.06 J	<0.06 J	<0.06 J	<0.06 J	<0.06 J	0.06 J	0.041	<0.06
BERYLLIUM (BE) TOTAL	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.003 J	<0.0003	<0.003 UJ
CADMIUM (CD) TOTAL	0.053 J	0.012 J	0.128 J	0.042 J	0.216 J	0.420 J	0.349	0.040
CHROMIUM (CR) TOTAL	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	0.009	<0.03 UJ
COPPER (CU) TOTAL							10.03	
IRON (FE) TOTAL	0.82 J	0.54 J	1.33 J	1.04 J	1.03 J	4.69 J	4.11	0.61
LEAD (PB) TOTAL							12.32	
MANGANESE (MN) TOTAL	0.04 J	0.02 J	0.05 J	0.05 J	0.05 J	0.18 J	0.159	0.06
MERCURY (HG) TOTAL	0.003	<0.003	0.010	0.006	0.013	0.012	0.0077 J	<0.003
NICKEL (NI) TOTAL	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	<0.03 J	0.017	<0.03
SELENIUM (SE) TOTAL	<0.15 J	<0.15 J	<0.15 J	<0.15 J	<0.15 J	<0.15 J	<0.02	<0.15
ZINC (ZN) TOTAL							3.64	

All quantities in micrograms per cubic meter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 05-11-1989

SUMMARY OF AIR FILTER QUALITY ANALYSIS
ANALYZED BY THE MONTANA AQB
FOR FIREHALL STRIP SITE

Date	Lab	Lead	Zinc	Copper	TSP
7/15/87	AQB	2.02	0.8	4.072	46.4
8/15/87	AQB	2.94	1.06	5.065	65.62
9/15/87	AQB	4.36	1.88	6.562	83.8
10/15/87	AQB	4.59	1.55	7.133	95
11/15/87	AQB	3.42	1.52	8.636	90.5
12/15/87	AQB	4.32	1.56	3.493	85.4
1/15/88	AQB	4.17	1	8.522	86.73
2/15/88	AQB	2.01	0.99	4.585	63.5
3/15/88	AQB	1.74	0.85	2.415	46
4/15/88	AQB	3.1	1.2	2.358	65.2
5/15/88	AQB	2.14	0.96	2.677	48.7
6/15/88	AQB	3.71	1.52	4.077	67.4

0211215

APPENDIX 8-1

GROUNDWATER FLOW AND CONTAMINANT TRANSPORT

SIMULATION OUTPUT FILES

Includes:

Steady-State PLASM External File for Groundwater Flow

31 Year Arsenic Transport Simulation

500 Year Arsenic Transport Simulation (100 Year Increments)

1.25 Year Sulfate Transport Simulation

0211216

STEADY-STATE PLASM EXTERNAL FILE FOR GROUNDWATER FLOW

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name:AEH13.PLA. EXTERNAL FILE FOR PLASM PROGRAM
U
N
Y
 1000000

C

 7   774.2393   1   7.48052
 20   30   0   0   0
 1   1   55000   55000   1E+21   3814   0   0   0   0   3645   500   500
 1   2   45000   45000   .15   3800   0   0   0   0   3655   500   500
 1   3   35000   35000   .15   3800   0   0   0   0   3665   500   500
 1   4   29000   29000   .15   3804   0   .3   3828   3826   3675   500   500
 1   5   124000   124000   .15   3809   0   0   0   0   3685   500   500
 1   6   114000   114000   .15   3809   0   0   0   0   3695   500   500
 1   7   104000   104000   .15   3809   0   0   0   0   3705   500   500
 1   8   94000   94000   .15   3809   0   0   0   0   3715   500   500
 1   9   95000   95000   .15   3820   0   0   0   0   3725   500   500
 1   10   100000   100000   .15   3835   0   0   0   0   3735   500   500
 1   11   3775000   3775000   .15   3775   0   .025   3835   3833   3745   500   500
 1   12   0   0   .15   3915   0   0   0   0   100   0   0
 1   13   0   0   .15   3915   0   0   0   0   100   0   0
 1   14   0   0   .15   3915   0   0   0   0   100   0   0
 1   15   0   0   .15   3915   0   0   0   0   100   0   0
 1   16   0   0   .15   3915   0   0   0   0   100   0   0
 1   17   0   0   .15   3915   0   0   0   0   100   0   0
 1   18   0   0   .15   3915   0   0   0   0   100   0   0
 1   19   0   0   .15   3915   0   0   0   0   100   0   0
 1   20   0   0   .15   3915   0   0   0   0   100   0   0
 1   21   0   0   .15   3915   0   0   0   0   100   0   0
 1   22   0   0   .15   3915   0   0   0   0   100   0   0
 1   23   0   0   .15   3915   0   0   0   0   100   0   0
 1   24   0   0   .15   3915   0   0   0   0   100   0   0
 1   25   0   0   .15   3915   0   0   0   0   100   0   0
 1   26   0   0   .15   3915   0   0   0   0   100   0   0
 1   27   0   0   .15   3915   0   0   0   0   100   0   0
 1   28   0   0   .15   3915   0   0   0   0   100   0   0
 1   29   0   0   .15   3915   0   0   0   0   100   0   0
 1   30   0   0   .15   3915   0   0   0   0   100   0   0
 2   1   55000   55000   1E+21   3814   0   0   0   0   3645   500   500
 2   2   45000   45000   .15   3800   0   0   0   0   3655   500   500
 2   3   35000   35000   .15   3800   0   0   0   0   3665   500   500
 2   4   29000   29000   .15   3804   0   0   0   0   3675   500   500
 2   5   124000   124000   .15   3809   0   .3   3830   3828   3685   500   500
 2   6   114000   114000   .15   3809   0   0   0   0   3695   500   500
 2   7   104000   104000   .15   3809   0   0   0   0   3705   500   500
 2   8   94000   94000   .15   3809   0   0   0   0   3715   500   500
 2   9   95000   95000   .15   3820   0   0   0   0   3725   500   500
 2   10   100000   100000   .15   3835   0   0   0   0   3735   500   500
 2   11   90000   90000   .15   3835   0   .025   3836   3834   3745   500   500
 2   12   0   0   .15   3915   0   0   0   0   100   0   0
 2   13   0   0   .15   3915   0   0   0   0   100   0   0
 2   14   0   0   .15   3915   0   0   0   0   100   0   0
 2   15   0   0   .15   3915   0   0   0   0   100   0   0
 2   16   0   0   .15   3915   0   0   0   0   100   0   0
 2   17   0   0   .15   3915   0   0   0   0   100   0   0
 2   18   0   0   .15   3915   0   0   0   0   100   0   0
 2   19   0   0   .15   3915   0   0   0   0   100   0   0
 2   20   0   0   .15   3915   0   0   0   0   100   0   0
 2   21   0   0   .15   3915   0   0   0   0   100   0   0
 2   22   0   0   .15   3915   0   0   0   0   100   0   0
 2   23   0   0   .15   3915   0   0   0   0   100   0   0
 2   24   0   0   .15   3915   0   0   0   0   100   0   0
 2   25   0   0   .15   3915   0   0   0   0   100   0   0
 2   26   0   0   .15   3915   0   0   0   0   100   0   0
 2   27   0   0   .15   3915   0   0   0   0   100   0   0
 2   28   0   0   .15   3915   0   0   0   0   100   0   0
 2   29   0   0   .15   3915   0   0   0   0   100   0   0
 2   30   0   0   .15   3915   0   0   0   0   100   0   0
 3   1   55000   55000   1E+21   3813.75   0   0   0   0   3645   500   500
 3   2   45000   45000   .15   3800   0   0   0   0   3655   500   500
 3   3   35000   35000   .15   3800   0   0   0   0   3665   500   500
 3   4   29000   29000   .15   3804   0   0   0   0   3675   500   500
 3   5   124000   124000   .15   3809   0   0   0   0   3685   500   500
 3   6   114000   114000   .15   3809   0   .3   3832   3830   3695   500   500
 3   7   104000   104000   .15   3809   0   0   0   0   3705   500   500
 3   8   94000   94000   .15   3809   0   0   0   0   3715   500   500
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 3   13   70000   70000   .15   3835   0   .025   3839   3837   3765   500   500
 3   14   0   0   .15   3915   0   0   0   0   100   0   0
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8	16	60000	60000	.15	3855	0	0	0	0	3795	500	500
8	17	50000	50000	.15	3855	0	0	0	0	3805	500	500
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11	20	30000	30000	.15	3865	0	0	0	0	3835	500	500
11	21	24000	24000	.15	3869	0	.1	3870	3868	3845	500	500
11	22	17000	17000	.15	3872	0	0	0	0	3855	500	500
11	23	0	0	.15	3915	0	0	0	0	100	0	0
11	24	0	0	.15	3915	0	0	0	0	100	0	0
11	25	0	0	.15	3915	0	0	0	0	100	0	0
11	26	0	0	.15	3915	0	0	0	0	100	0	0
11	27	0	0	.15	3915	0	0	0	0	100	0	0
11	28	0	0	.15	3915	0	0	0	0	100	0	0
11	29	0	0	.15	3915	0	0	0	0	100	0	0
11	30	0	0	.15	3915	0	0	0	0	100	0	0
12	1	55000	55000	1E+21	3813.5	0	0	0	0	3645	500	500
12	2	45000	45000	.15	3800	0	0	0	0	3655	500	500
12	3	35000	35000	.15	3800	0	0	0	0	3665	500	500
12	4	29000	29000	.15	3804	0	0	0	0	3675	500	500
12	5	124000	124000	.15	3809	0	0	0	0	3685	500	500
12	6	114000	114000	.15	3809	0	0	0	0	3695	500	500
12	7	104000	104000	.15	3809	0	0	0	0	3705	500	500
12	8	94000	94000	.15	3809	0	0	0	0	3715	500	500

12	9	95000	95000	.15	3820	0	0	0	0	3725	500	500
12	10	100000	100000	.15	3835	0	0	0	0	3735	500	500
12	11	90000	90000	.15	3835	0	0	0	0	3745	500	500
12	12	80000	80000	.15	3835	0	0	0	0	3755	500	500
12	13	70000	70000	.15	3835	0	0	0	0	3765	500	500
12	14	60000	60000	.15	3835	0	.3	3847	3845	3775	500	500
12	15	50000	50000	.15	3835	0	0	0	0	3785	500	500
12	16	60000	60000	.15	3855	0	0	0	0	3795	500	500
12	17	50000	50000	.15	3855	0	0	0	0	3805	500	500
12	18	46000	46000	.15	3861	0	0	0	0	3815	500	500
12	19	36000	36000	.15	3861	0	0	0	0	3825	500	500
12	20	30000	30000	.15	3865	0	0	0	0	3835	500	500
12	21	24000	24000	.15	3869	0	0	0	0	3845	500	500
12	22	17000	17000	.15	3872	0	.125	3874	3872	3855	500	500
12	23	9000	9000	.15	3874	0	0	0	0	3865	500	500
12	24	0	0	.15	3915	0	0	0	0	100	0	0
12	25	0	0	.15	3915	0	0	0	0	100	0	0
12	26	0	0	.15	3915	0	0	0	0	100	0	0
12	27	0	0	.15	3915	0	0	0	0	100	0	0
12	28	0	0	.15	3915	0	0	0	0	100	0	0
12	29	0	0	.15	3915	0	0	0	0	100	0	0
12	30	0	0	.15	3915	0	0	0	0	100	0	0
13	1	55000	55000	1E+21	3813.25	0	0	0	0	3645	500	500
13	2	45000	45000	.15	3800	0	0	0	0	3655	500	500
13	3	35000	35000	.15	3800	0	0	0	0	3665	500	500
13	4	29000	29000	.15	3804	0	0	0	0	3675	500	500
13	5	124000	124000	.15	3809	0	0	0	0	3685	500	500
13	6	114000	114000	.15	3809	0	0	0	0	3695	500	500
13	7	104000	104000	.15	3809	0	0	0	0	3705	500	500
13	8	94000	94000	.15	3809	0	0	0	0	3715	500	500
13	9	95000	95000	.15	3820	0	0	0	0	3725	500	500
13	10	100000	100000	.15	3835	0	0	0	0	3735	500	500
13	11	90000	90000	.15	3835	0	0	0	0	3745	500	500
13	12	80000	80000	.15	3835	0	0	0	0	3755	500	500
13	13	70000	70000	.15	3835	0	0	0	0	3765	500	500
13	14	60000	60000	.15	3835	0	0	0	0	3775	500	500
13	15	50000	50000	.15	3835	0	.3	3851	3849	3785	500	500
13	16	60000	60000	.15	3855	0	0	0	0	3795	500	500
13	17	50000	50000	.15	3855	0	0	0	0	3805	500	500
13	18	46000	46000	.15	3861	0	0	0	0	3815	500	500
13	19	36000	36000	.15	3861	0	0	0	0	3825	500	500
13	20	30000	30000	.15	3865	0	0	0	0	3835	500	500
13	21	24000	24000	.15	3869	0	0	0	0	3845	500	500
13	22	17000	17000	.15	3872	0	0	0	0	3855	500	500
13	23	9000	9000	.15	3874	0	.01	3881	3879	3865	500	500
13	24	8000	8000	.15	3883	0	0	0	0	3875	500	500
13	25	0	0	.15	3915	0	0	0	0	100	0	0
13	26	0	0	.15	3915	0	0	0	0	100	0	0
13	27	0	0	.15	3915	0	0	0	0	100	0	0
13	28	0	0	.15	3915	0	0	0	0	100	0	0
13	29	0	0	.15	3915	0	0	0	0	100	0	0
13	30	0	0	.15	3915	0	0	0	0	100	0	0
14	1	55000	55000	1E+21	3813.25	0	0	0	0	3645	500	500
14	2	45000	45000	.15	3800	0	0	0	0	3655	500	500
14	3	35000	35000	.15	3800	0	0	0	0	3665	500	500
14	4	29000	29000	.15	3804	0	0	0	0	3675	500	500
14	5	124000	124000	.15	3809	0	0	0	0	3685	500	500
14	6	114000	114000	.15	3809	0	0	0	0	3695	500	500
14	7	104000	104000	.15	3809	0	0	0	0	3705	500	500
14	8	94000	94000	.15	3809	0	0	0	0	3715	500	500
14	9	95000	95000	.15	3820	0	0	0	0	3725	500	500
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14	14	60000	60000	.15	3835	0	0	0	0	3775	500	500
14	15	50000	50000	.15	3835	0	0	0	0	3785	500	500
14	16	60000	60000	.15	3855	0	.5	3856	3854	3795	500	500
14	17	50000	50000	.15	3855	0	0	0	0	3805	500	500
14	18	46000	46000	.15	3861	0	0	0	0	3815	500	500
14	19	36000	36000	.15	3861	0	0	0	0	3825	500	500
14	20	30000	30000	.15	3865	0	0	0	0	3835	500	500
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14	22	17000	17000	.15	3872	0	0	0	0	3855	500	500
14	23	9000	9000	.15	3874	0	0	0	0	3865	500	500
14	24	8000	8000	.15	3883	0	0	0	0	3875	500	500
14	25	8000	8000	.15	3893	0	0	0	0	3885	500	500
14	26	8000	8000	.15	3896	0	0	0	0	3888	500	500
14	27	0	0	.15	3915	0	0	0	0	100	0	0
14	28	0	0	.15	3915	0	0	0	0	100	0	0
14	29	0	0	.15	3915	0	0	0	0	100	0	0
14	30	0	0	.15	3915	0	0	0	0	100	0	0
15	1	55000	55000	1E+21	3813.25	0	0	0	0	3645	500	500
15	2	45000	45000	.15	3800	0	0	0	0	3655	500	500
15	3	35000	35000	.15	3800	0	0	0	0	3665	500	500
15	4	29000	29000	.15	3804	0	0	0	0	3675	500	500
15	5	124000	124000	.15	3809	0	0	0	0	3685	500	500
15	6	114000	114000	.15	3809	0	0	0	0	3695	500	500

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15 7 104000 104000 .15 3809 0 0 0 0 3705 500 500
15 8 94000 94000 .15 3809 0 0 0 0 3715 500 500
15 9 95000 95000 .15 3820 0 0 0 0 3725 500 500
15 10 100000 100000 .15 3835 0 0 0 0 3735 500 500
15 11 90000 90000 .15 3835 0 0 0 0 3745 500 500
15 12 80000 80000 .15 3835 0 0 0 0 3755 500 500
15 13 70000 70000 .15 3835 0 0 0 0 3765 500 500
15 14 60000 60000 .15 3835 0 0 0 0 3775 500 500
15 15 50000 50000 .15 3835 0 0 0 0 3785 500 500
15 16 60000 60000 .15 3855 0 0 0 0 3795 500 500
15 17 50000 50000 .15 3855 0 .75 3861 3859 3805 500 500
15 18 46000 46000 .15 3861 0 .75 3865 3863 3815 500 500
15 19 36000 36000 .15 3861 0 .65 3870 3868 3825 500 500
15 20 30000 30000 .15 3865 0 .5 3874 3872 3835 500 500
15 21 24000 24000 .15 3869 0 0 0 0 3845 500 500
15 22 17000 17000 .15 3872 0 0 0 0 3855 500 500
15 23 9000 9000 .15 3874 0 0 0 0 3865 500 500
15 24 8000 8000 .15 3883 0 0 0 0 3875 500 500
15 25 8000 8000 .15 3893 0 0 0 0 3885 500 500
15 26 8000 8000 .15 3896 0 0 0 0 3888 500 500
15 27 10000 10000 .15 3900 0 0 0 0 3890 500 500
15 28 16000 16000 .15 3911 0 0 0 0 3895 500 500
15 29 13000 13000 .15 3913 0 1 3915 3907 3900 500 500
15 30 10000 10000 1E+21 3914.5 0 0 0 0 3905 500 500
16 1 55000 55000 1E+21 3813.25 0 0 0 0 3645 500 500
16 2 45000 45000 .15 3800 0 0 0 0 3655 500 500
16 3 35000 35000 .15 3800 0 0 0 0 3665 500 500
16 4 29000 29000 .15 3804 0 0 0 0 3675 500 500
16 5 124000 124000 .15 3809 0 0 0 0 3685 500 500
16 6 114000 114000 .15 3809 0 0 0 0 3695 500 500
16 7 104000 104000 .15 3809 0 0 0 0 3705 500 500
16 8 94000 94000 .15 3809 0 0 0 0 3715 500 500
16 9 95000 95000 .15 3820 0 0 0 0 3725 500 500
16 10 100000 100000 .15 3835 0 0 0 0 3735 500 500
16 11 90000 90000 .15 3835 0 0 0 0 3745 500 500
16 12 80000 80000 .15 3835 0 0 0 0 3755 500 500
16 13 70000 70000 .15 3835 0 0 0 0 3765 500 500
16 14 60000 60000 .15 3835 0 0 0 0 3775 500 500
16 15 50000 50000 .15 3835 0 0 0 0 3785 500 500
16 16 60000 60000 .15 3855 0 0 0 0 3795 500 500
16 17 50000 50000 .15 3855 0 0 0 0 3805 500 500
16 18 46000 46000 .15 3861 0 0 0 0 3815 500 500
16 19 36000 36000 .15 3861 0 0 0 0 3825 500 500
16 20 30000 30000 .15 3865 0 0 0 0 3835 500 500
16 21 24000 24000 .15 3869 0 .75 3878 3876 3845 500 500
16 22 17000 17000 .15 3872 0 0 0 0 3855 500 500
16 23 9000 9000 .15 3874 0 0 0 0 3865 500 500
16 24 8000 8000 .15 3883 0 0 0 0 3875 500 500
16 25 8000 8000 .15 3893 0 0 0 0 3885 500 500
16 26 8000 8000 .15 3896 0 0 0 0 3888 500 500
16 27 10000 10000 .15 3900 0 1 3914 3906 3890 500 500
16 28 16000 16000 .15 3911 0 0 0 0 3895 500 500
16 29 13000 13000 .15 3913 0 1 3915 3907 3900 500 500
16 30 10000 10000 1E+21 3914.5 0 0 0 0 3905 500 500
17 1 55000 55000 1E+21 3813.25 0 0 0 0 3645 500 500
17 2 45000 45000 .15 3800 0 0 0 0 3655 500 500
17 3 35000 35000 .15 3800 0 0 0 0 3665 500 500
17 4 29000 29000 .15 3804 0 0 0 0 3675 500 500
17 5 124000 124000 .15 3809 0 0 0 0 3685 500 500
17 6 114000 114000 .15 3809 0 0 0 0 3695 500 500
17 7 104000 104000 .15 3809 0 0 0 0 3705 500 500
17 8 94000 94000 .15 3809 0 0 0 0 3715 500 500
17 9 95000 95000 .15 3820 0 0 0 0 3725 500 500
17 10 100000 100000 .15 3835 0 0 0 0 3735 500 500
17 11 90000 90000 .15 3835 0 0 0 0 3745 500 500
17 12 80000 80000 .15 3835 0 0 0 0 3755 500 500
17 13 70000 70000 .15 3835 0 0 0 0 3765 500 500
17 14 60000 60000 .15 3835 0 0 0 0 3775 500 500
17 15 50000 50000 .15 3835 0 0 0 0 3785 500 500
17 16 60000 60000 .15 3855 0 0 0 0 3795 500 500
17 17 50000 50000 .15 3855 0 0 0 0 3805 500 500
17 18 46000 46000 .15 3861 0 0 0 0 3815 500 500
17 19 36000 36000 .15 3861 0 0 0 0 3825 500 500
17 20 30000 30000 .15 3865 0 0 0 0 3835 500 500
17 21 24000 24000 .15 3869 0 .75 3878 3876 3845 500 500
17 22 17000 17000 .15 3872 0 0 0 0 3855 500 500
17 23 9000 9000 .15 3874 0 0 0 0 3865 500 500
17 24 8000 8000 .15 3883 0 0 0 0 3875 500 500
17 25 8000 8000 .15 3893 0 0 0 0 3885 500 500
17 26 8000 8000 .15 3896 0 0 0 0 3888 500 500
17 27 10000 10000 .15 3900 0 1 3914 3906 3890 500 500
17 28 16000 16000 .15 3911 0 1 3914 3906 3895 500 500
17 29 13000 13000 .15 3913 0 1 3915 3907 3900 500 500
17 30 10000 10000 1E+21 3914.5 0 0 0 0 3905 500 500
18 1 55000 55000 1E+21 3813 0 0 0 0 3645 500 500
18 2 45000 45000 .15 3800 0 0 0 0 3655 500 500
18 3 35000 35000 .15 3800 0 0 0 0 3665 500 500
18 4 29000 29000 .15 3804 0 0 0 0 3675 500 500
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18	5	124000	124000	.15	3809	0	0	0	0	3685	500	500
18	6	114000	114000	.15	3809	0	0	0	0	3695	500	500
18	7	104000	104000	.15	3309	0	0	0	0	3705	500	500
18	8	94000	94000	.15	3809	0	0	0	0	3715	500	500
18	9	95000	95000	.15	3820	0	0	0	0	3725	500	500
18	10	100000	100000	.15	3835	0	0	0	0	3735	500	500
18	11	90000	90000	.15	3835	0	0	0	0	3745	500	500
18	12	80000	80000	.15	3835	0	0	0	0	3755	500	500
18	13	70000	70000	.15	3835	0	0	0	0	3765	500	500
18	14	60000	60000	.15	3835	0	0	0	0	3775	500	500
18	15	50000	50000	.15	3835	0	0	0	0	3785	500	500
18	16	60000	60000	.15	3855	0	0	0	0	3795	500	500
18	17	50000	50000	.15	3855	0	0	0	0	3805	500	500
18	18	46000	46000	.15	3861	0	0	0	0	3815	500	500
18	19	36000	36000	.15	3861	0	0	0	0	3825	500	500
18	20	30000	30000	.15	3865	0	0	0	0	3835	500	500
18	21	24000	24000	.15	3869	0	0	0	0	3845	500	500
18	22	17000	17000	.15	3872	0	.5	3881	3879	3855	500	500
18	23	9000	9000	.15	3874	0	.5	3886	3884	3865	500	500
18	24	8000	8000	.15	3883	0	.3	3891	3889	3875	500	500
18	25	8000	8000	.15	3893	0	.3	3895	3893	3885	500	500
18	26	8000	8000	.15	3896	0	.3	3897	3895	3888	500	500
18	27	10000	10000	.15	3900	0	.3	3899	3897	3390	500	500
18	28	16000	16000	.15	3911	0	.3	3911	3909	3895	500	500
18	29	13000	13000	.15	3913	0	.3	3914	3912	3900	500	500
18	30	10000	10000	1E+21	3915.5	0	0	0	0	3905	500	500
19	1	55000	55000	1E+21	3813	0	0	0	0	3645	500	500
19	2	45000	45000	.15	3800	0	0	0	0	3655	500	500
19	3	35000	35000	.15	3800	0	0	0	0	3665	500	500
19	4	29000	29000	.15	3804	0	0	0	0	3675	500	500
19	5	124000	124000	.15	3809	0	0	0	0	3685	500	500
19	6	114000	114000	.15	3809	0	0	0	0	3695	500	500
19	7	104000	104000	.15	3809	0	0	0	0	3705	500	500
19	8	94000	94000	.15	3809	0	0	0	0	3715	500	500
19	9	95000	95000	.15	3820	0	0	0	0	3725	500	500
19	10	100000	100000	.15	3835	0	0	0	0	3735	500	500
19	11	90000	90000	.15	3835	0	0	0	0	3745	500	500
19	12	80000	80000	.15	3835	0	0	0	0	3755	500	500
19	13	70000	70000	.15	3835	0	0	0	0	3765	500	500
19	14	60000	60000	.15	3835	0	0	0	0	3775	500	500
19	15	50000	50000	.15	3835	0	0	0	0	3785	500	500
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19	19	36000	36000	.15	3861	0	0	0	0	3825	500	500
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19	21	24000	24000	.15	3869	0	0	0	0	3845	500	500
19	22	17000	17000	.15	3872	0	0	0	0	3855	500	500
19	23	9000	9000	.15	3874	0	0	0	0	3865	500	500
19	24	8000	8000	.15	3883	0	0	0	0	3875	500	500
19	25	8000	8000	.15	3893	0	0	0	0	3885	500	500
19	26	8000	8000	.15	3896	0	0	0	0	3888	500	500
19	27	10000	10000	.15	3900	0	0	0	0	3890	500	500
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19	30	10000	10000	1E+21	3916.5	0	0	0	0	3905	500	500
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20	3	35000	35000	.15	3800	0	0	0	0	3665	500	500
20	4	29000	29000	.15	3804	0	0	0	0	3675	500	500
20	5	124000	124000	.15	3809	0	0	0	0	3685	500	500
20	6	114000	114000	.15	3809	0	0	0	0	3695	500	500
20	7	104000	104000	.15	3809	0	0	0	0	3705	500	500
20	8	94000	94000	.15	3809	0	0	0	0	3715	500	500
20	9	95000	95000	.15	3820	0	0	0	0	3725	500	500
20	10	100000	100000	.15	3835	0	0	0	0	3735	500	500
20	11	90000	90000	.15	3835	0	0	0	0	3745	500	500
20	12	80000	80000	.15	3835	0	0	0	0	3755	500	500
20	13	70000	70000	.15	3835	0	0	0	0	3765	500	500
20	14	60000	60000	.15	3835	0	0	0	0	3775	500	500
20	15	50000	50000	.15	3835	0	0	0	0	3785	500	500
20	16	60000	60000	.15	3855	0	0	0	0	3795	500	500
20	17	50000	50000	.15	3855	0	0	0	0	3805	500	500
20	18	46000	46000	.15	3861	0	0	0	0	3815	500	500
20	19	36000	36000	.15	3861	0	0	0	0	3825	500	500
20	20	30000	30000	.15	3865	0	0	0	0	3835	500	500
20	21	24000	24000	.15	3869	0	0	0	0	3845	500	500
20	22	17000	17000	.15	3872	0	0	0	0	3855	500	500
20	23	9000	9000	.15	3874	0	0	0	0	3865	500	500
20	24	8000	8000	.15	3883	0	0	0	0	3875	500	500
20	25	8000	8000	.15	3893	0	0	0	0	3885	500	500
20	26	8000	8000	.15	3896	0	0	0	0	3888	500	500
20	27	10000	10000	.15	3900	0	0	0	0	3890	500	500
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20	29	13000	13000	.15	3913	0	0	0	0	3900	500	500
20	30	10000	10000	1E+21	3917.5	0	0	0	0	3905	500	500
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31 YEAR ARSENIC TRANSPORT SIMULATION

A

//////////BASIC TRANSPORT COEFFICIENTS\\\\\\\\\\

POROSITY = .2
LONGITUDINAL DISPERSIVITY = 300
TRANSVERSE DISPERSIVITY (FT) = 5
RETARDATION COEFFICIENT = 30
PARTICLE MASS (LBS) = 3000

////////////////////////\\\\\\\\\\\\\\\\\\\\\\\\\\\\

There are 23 sinks

Sink #	I coordinate	J coordinate	Withdrawal rate
1	1	30	1
2	2	30	1
3	3	30	1
4	4	30	1
5	5	30	1
6	6	30	1
7	7	30	1
8	8	30	1
9	9	30	1
10	10	30	1
11	11	30	1
12	12	30	1
13	13	30	1
14	14	30	1
15	15	30	1
16	16	30	1
17	17	30	1
18	18	4	93260.75
19	18	5	34330.08
20	18	6	22517.58
21	18	30	1
22	19	30	1
23	20	30	1

STARTING TIME OF SIMULATIN (DAYS) = 0

//////////////////////PARTICLES\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
LINE NUMBER 1
LINE COORDINATES:
BEGINNING POINT (I,J) = 15 , 4 GRID
END POINT OF LINE (I,J) = 17 , 4 GRID
NUMBER OF PARTICLES = 15
SYSTEM PARTICLES = 15
PARTICLES ON A LINE
LINE NUMBER 2
LINE COORDINATES:

0211227

```
   BEGINNING POINT (I,J) =  15 , 7  GRID
   END POINT OF LINE (I,J) =  15 , 7  GRID
   NUMBER OF PARTICLES =  20
 SYSTEM PARTICLES =  35

  TOTAL SYSTEM PARTICLES =  35
\\\\\\\\\\\\\\\\\\\\\\\\//////////////////////////
```

B

```
ACCUMULATED TIME =  0  DAYS      PARTICLES =  35
PARTICLE MAP
------------------------------
        COORDINATES ARE IN FEET
    --------------------------------------------
14 |  +  +  +  +  +  +  +  +  +  +  +
13 |  +  +  +  +  +  +  +  +  +  +  +
12 |  +  +  +  +  +  +  +  +  +  +  +
11 |  +  +  +  +  +  +  +  +  +  +  +
10 |  +  +  +  +  +  +  +  +  +  +  +
9  |  +  +  +  +  +  +  +  +  +  +  +
8  |  +  +  +  +  +  +  +  +  +  +  +
7  |  +  +  +  +  + 20  +  +  +  +  +
6  |  +  +  +  +  +  +  +  +  +  +  +
5  |  +  +  +  +  +  +  +  +  +  +  +
4  |  +  +  +  +  +  4  7  4  +  +  +
    --------------------------------------------

      1  1  1  1  1  1  1  1  1  1  2
      0  1  2  3  4  5  6  7  8  9  0
```

RD30-0Y
T= 0 years

```
DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

    PRESENT SIMULATION TIME =  0   DAYS
     INCREMENTAL SIMULATION TIME =  1000  DAYS
DMAX =  200  FT

NP =  35
```

```
ACCUMULATED TIME =  1000  DAYS      PARTICLES =  35
PARTICLE MAP
------------------------------
        COORDINATES ARE IN FEET
    --------------------------------------------
14 |  +  +  +  +  +  +  +  +  +  +  +
13 |  +  +  +  +  +  +  +  +  +  +  +
12 |  +  +  +  +  +  +  +  +  +  +  +
11 |  +  +  +  +  +  +  +  +  +  +  +
10 |  +  +  +  +  +  +  +  +  +  +  +
9  |  +  +  +  +  2  +  +  +  +  +  +
8  |  +  +  +  +  1  2  +  +  +  +  +
7  |  +  +  +  +  + 10  +  1  +  +  +
6  |  +  +  +  +  +  4  1  +  +  +  +
5  |  +  +  +  +  +  1  +  +  +  +  +
4  |  +  +  +  +  +  3  3  1  +  +  +
```

0211228

c

```
  -------------------------------------------

   1  1  1  1  1  1  1  1  1  1  2
   0  1  2  3  4  5  6  7  8  9  0
```

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
ACCUMULATED TIME =  1000  DAYS      PARTICLES =  35
CONCENTRATION MAP IN PPM
------------------------------
       COORDINATES ARE IN FEET
  -------------------------------------------
14 |  +  +  +  +  +  +  +  +  +  +  +
13 |  +  +  +  +  +  +  +  +  +  +  +
12 |  +  +  +  +  +  +  +  +  +  +  +
11 |  +  +  +  +  +  +  +  +  +  +  +
10 |  +  +  +  +  +  +  +  +  +  +  +
 9 |  +  +  +  +  5  +  +  +  +  +  +
 8 |  +  +  +  +  3  5  +  +  +  +  +
 7 |  +  +  +  +  + 44  +  4  +  +  +
 6 |  +  +  +  +  + 29  6  +  +  +  +
 5 |  +  +  +  +  +  4  +  +  +  +  +
 4 |  +  +  +  +  +  8  7  2  +  +  +
  -------------------------------------------

   1  1  1  1  1  1  1  1  1  1  2
   0  1  2  3  4  5  6  7  8  9  0
```

RD30-34

T= 3years

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
    ////////////////////PARTICLES\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
   LINE NUMBER 1
        LINE COORDINATES:
        BEGINNING POINT (I,J) =  15 , 4  GRID
        END POINT OF LINE (I,J) =  17 , 4  GRID
        NUMBER OF PARTICLES =  10
     SYSTEM PARTICLES =  45
PARTICLES ON A LINE
   LINE NUMBER 2
        LINE COORDINATES:
        BEGINNING POINT (I,J) =  15 , 7  GRID
        END POINT OF LINE (I,J) =  15 , 7  GRID
        NUMBER OF PARTICLES =  20
     SYSTEM PARTICLES =  65

       TOTAL SYSTEM PARTICLES =  65
    \\\\\\\\\\\\\\\\\\\\//////////////////////////
    PRESENT SIMULATION TIME =  1000   DAYS
     INCREMENTAL SIMULATION TIME =  1000  DAYS
DMAX =  200  FT

NP =  65
```

0211229

D

```
ACCUMULATED TIME =  2000  DAYS      PARTICLES =  65
PARTICLE MAP
------------------------------
        COORDINATES ARE IN FEET
     ------------------------------------------
14  |  +   +   +   +   +   +   +   +   +   +   +
13  |  +   +   +   +   +   +   +   +   +   +   +
12  |  +   +   +   +   +   +   +   +   +   +   +
11  |  +   +   +   +   +   +   +   +   +   +   +
10  |  +   +   +   1   +   +   +   +   +   +   +
9   |  +   +   +   +   5   +   +   +   +   +   +
8   |  +   +   +   +   3   9   1   +   +   +   +
7   |  +   +   +   +   1  18   3   +   +   +   +
6   |  +   +   +   +   +   4   1   +   +   +   +
5   |  +   +   +   +   +   +   +   1   +   +   +
4   |  +   +   +   +   +   6   2   1   +   +   +
     ------------------------------------------

       1   1   1   1   1   1   1   1   1   1   2
       0   1   2   3   4   5   6   7   8   9   0


DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.
```

```
ACCUMULATED TIME =  2000  DAYS      PARTICLES =  65
CONCENTRATION MAP IN PPM
------------------------------
        COORDINATES ARE IN FEET
     ------------------------------------------
14  |  +   +   +   +   +   +   +   +   +   +   +
13  |  +   +   +   +   +   +   +   +   +   +   +
12  |  +   +   +   +   +   +   +   +   +   +   +
11  |  +   +   +   +   +   +   +   +   +   +   +
10  |  +   +   +   2   +   +   +   +   +   +   +
9   |  +   +   +   +  12   +   +   +   +   +   +
8   |  +   +   +   +  10  25   3   +   +   +   +
7   |  +   +   +   +   6  80  12   +   +   +   +
6   |  +   +   +   +   +  29   6   +   +   +   +
5   |  +   +   +   +   +   +   +   4   +   +   +
4   |  +   +   +   +   +  17   4   2   +   +   +
     ------------------------------------------

       1   1   1   1   1   1   1   1   1   1   2
       0   1   2   3   4   5   6   7   8   9   0


DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.
```

RD30 -5Y

T= 5 years

```
//////////////////////PARTICLES\\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
```

E

```
   LINE NUMBER 1
        LINE COORDINATES:
        BEGINNING POINT (I,J) =  15 , 4  GRID
        END POINT OF LINE (I,J) =  17 , 4  GRID
        NUMBER OF PARTICLES =  10
      SYSTEM PARTICLES =  75
PARTICLES ON A LINE
   LINE NUMBER 2
        LINE COORDINATES:
        BEGINNING POINT (I,J) =  15 , 7  GRID
        END POINT OF LINE (I,J) =  15 , 7  GRID
        NUMBER OF PARTICLES =  40
      SYSTEM PARTICLES =  115

       TOTAL SYSTEM PARTICLES =  115
    \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\///////////////////////////
     PRESENT SIMULATION TIME =  2000   DAYS
      INCREMENTAL SIMULATION TIME =  1000  DAYS
DMAX =  200  FT

NP =  115
```

```
ACCUMULATED TIME =  3000  DAYS     PARTICLES =  115
PARTICLE MAP
------------------------------
       COORDINATES ARE IN FEET
    ------------------------------------------
14 | +  +  +  +  +  +  +  +  +  +  +
13 | +  +  +  +  +  +  +  +  +  +  +
12 | +  +  +  +  +  +  +  +  +  +  +
11 | +  +  +  +  +  +  +  +  +  +  +
10 | +  +  +  1  +  +  +  +  +  +  +
9  | +  +  +  +  11 3  +  +  +  +  +
8  | +  +  +  +  11 23 1  +  +  +  +
7  | +  +  +  +  1  23 2  +  +  +  +
6  | +  +  +  +  1  8  2  +  +  +  +
5  | +  +  +  +  1  1  +  +  +  +  +
4  | +  +  +  +  +  6  5  4  +  +  +
    ------------------------------------------

     1  1  1  1  1  1  1  1  1  1  2
     0  1  2  3  4  5  6  7  8  9  0


DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.


ACCUMULATED TIME =  3000  DAYS     PARTICLES =  115
CONCENTRATION MAP IN PPM
------------------------------
       COORDINATES ARE IN FEET
    ------------------------------------------
14 | +  +  +  +  +  +  +  +  +  +  +
13 | +  +  +  +  +  +  +  +  +  +  +
12 | +  +  +  +  +  +  +  +  +  +  +
```

0211231

```
11 |  +   +   +   +   +   +   +   +   +   +   +
10 |  +   +   +   2   +   +   +   +   +   +   +
9  |  +   +   +   +  26   6   +   +   +   +   +
8  |  +   +   +   +  35  63   3   +   +   +   +
7  |  +   +   +   +   6 102   8   +   +   +   +
6  |  +   +   +   +  11  58  12   +   +   +   +
5  |  +   +   +   +   8   4   +   +   +   +   +
4  |  +   +   +   +   +  17  11   9   +   +   +
   ------------------------------------------------

      1   1   1   1   1   1   1   1   1   1   2
      0   1   2   3   4   5   6   7   8   9   0
```

RD30-84

T = 8 years

F

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
////////////////////PARTICLES\\\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
   LINE NUMBER 1
       LINE COORDINATES:
       BEGINNING POINT (I,J) =  15 , 4  GRID
       END POINT OF LINE (I,J) =  17 , 4  GRID
       NUMBER OF PARTICLES =  12
     SYSTEM PARTICLES =  127
PARTICLES ON A LINE
   LINE NUMBER 2
       LINE COORDINATES:
       BEGINNING POINT (I,J) =  15 , 7  GRID
       END POINT OF LINE (I,J) =  15 , 7  GRID
       NUMBER OF PARTICLES =  40
     SYSTEM PARTICLES =  167

      TOTAL SYSTEM PARTICLES =  167
    \\\\\\\\\\\\\\\\\\\\//////////////////////
    PRESENT SIMULATION TIME =  3000   DAYS
     INCREMENTAL SIMULATION TIME =  1000  DAYS
DMAX =  200  FT

NP =  167
```

```
ACCUMULATED TIME =  4000  DAYS      PARTICLES =  167
PARTICLE MAP
------------------------------

         COORDINATES ARE IN FEET
    ------------------------------------------------
14 |  +   +   +   +   +   +   +   +   +   +   +
13 |  +   +   +   +   +   +   +   +   +   +   +
12 |  +   +   +   +   +   +   +   +   +   +   +
11 |  +   +   +   2   +   +   +   +   +   +   +
10 |  +   +   +   +   5   +   +   +   +   +   +
9  |  +   +   +   +  27   3   +   +   +   +   +
8  |  +   +   +   1   8  35   2   +   +   +   +
7  |  +   +   +   +   2  38   3   1   +   +   +
6  |  +   +   +   +   +   5   +   +   +   +   +
5  |  +   +   +   +   +   3   +   +   +   +   +
```

6

```
4  |  +   +   +   +   +  [illegible] 10 [illegible]  +   +   +
      ------------------------------------------

      1   1   1   1   1   1   1   1   1   1   2
      0   1   2   3   4   5   6   7   8   9   0
```

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 4000 DAYS PARTICLES = 167

× CONCENTRATION MAP IN PPM

```
-----------------------------
       COORDINATES ARE IN FEET
      ------------------------------------------
14 |  +   +   +   +   +   +   +   +   +   +   +
13 |  +   +   +   +   +   +   +   +   +   +   +
12 |  +   +   +   +   +   +   +   +   +   +   +
11 |  +   +   +   3   +   +   +   +   +   +   +
10 |  +   +   +   +   9   +   +   +   +   +   +
9  |  +   +   +   +  65   6   +   +   +   +   +
8  |  +   +   +   4  26  96   5   +   +   +   +
7  |  +   +   +   +  11 168  12   4   +   +   +
6  |  +   +   +   +   +  36   +   +   +   +   +
5  |  +   +   +   +   +  13   +   +   +   +   +
4  |  +   +   +   +   +  14  22  13   +   +   +
      ------------------------------------------

      1   1   1   1   1   1   1   1   1   1   2
      0   1   2   3   4   5   6   7   8   9   0
```

RD30-10Y

T= 10years

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

////////////////////PARTICLES\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
  LINE NUMBER 1
    LINE COORDINATES:
    BEGINNING POINT (I,J) = 15 , 4 GRID
    END POINT OF LINE (I,J) = 17 , 4 GRID
    NUMBER OF PARTICLES = 12
   SYSTEM PARTICLES = 179
PARTICLES ON A LINE
  LINE NUMBER 2
    LINE COORDINATES:
    BEGINNING POINT (I,J) = 15 , 7 GRID
    END POINT OF LINE (I,J) = 15 , 7 GRID
    NUMBER OF PARTICLES = 40
   SYSTEM PARTICLES = 219

TOTAL SYSTEM PARTICLES = 219
\\\\\\\\\\\\\\\\\\\////////////////////////
PRESENT SIMULATION TIME = 4000 DAYS

INCREMENTAL SIMULATION TIME = 1000 DAYS
DMAX = 200 FT

NP = 218
CONCENTRATION IN PUMPED WELL NUMBER 20 , IN PPM, IS = 15.97045

ACCUMULATED TIME = 5000 DAYS PARTICLES = 218
PARTICLE MAP

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
14	+	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	+	2	1	+	+	+	+	+	+
10	+	+	+	5	11	+	1	+	+	+	+
9	+	+	+	+	29	7	+	+	+	+	+
8	+	+	+	1	17	53	2	+	+	+	+
7	+	+	+	+	1	36	2	2	+	+	+
6	+	+	+	+	2	4	+	1	+	+	+
5	+	+	+	+	+	2	1	+	+	+	+
4	+	+	+	+	+	2	10	4	+	+	+

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 5000 DAYS PARTICLES = 218
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
14	+	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	+	3	1	+	+	+	+	+	+
10	+	+	+	10	20	+	2	+	+	+	+
9	+	+	+	+	69	15	+	+	+	+	+
8	+	+	+	4	55	146	5	+	+	+	+
7	+	+	+	+	6	159	8	8	+	+	+
6	+	+	+	+	22	29	+	6	+	+	+
5	+	+	+	+	+	9	3	+	+	+	+
4	+	+	+	+	+	6	22	9	+	+	+

RD30-13Y
T= 13 years

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

I

////////////////////PARTICLES\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
LINE NUMBER 1
LINE COORDINATES:
BEGINNING POINT (I,J) = 15 , 4 GRID
END POINT OF LINE (I,J) = 17 , 4 GRID
NUMBER OF PARTICLES = 8
SYSTEM PARTICLES = 226

PARTICLES ON A LINE
LINE NUMBER 2
LINE COORDINATES:
BEGINNING POINT (I,J) = 15 , 7 GRID
END POINT OF LINE (I,J) = 15 , 7 GRID
NUMBER OF PARTICLES = 60
SYSTEM PARTICLES = 286

TOTAL SYSTEM PARTICLES = 286
\\\\\\\\\\\\\\\\\\\\//////////////////////

PRESENT SIMULATION TIME = 5000 DAYS
INCREMENTAL SIMULATION TIME = 1000 DAYS
DMAX = 200 FT

NP = 285
CONCENTRATION IN PUMPED WELL NUMBER 18 . IN PPM, IS = 3.856027

ACCUMULATED TIME = 6000 DAYS PARTICLES = 285
PARTICLE MAP

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
14	+	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	1	4	2	+	+	+	+	+	+
10	+	+	+	9	11	+	1	+	+	+	+
9	+	+	+	+	50	16	1	+	+	+	+
8	+	+	+	1	21	55	3	+	+	+	+
7	+	+	+	1	5	47	+	2	+	+	+
6	+	+	+	+	+	8	1	1	+	+	+
5	+	+	+	+	+	1	+	+	+	+	+
4	+	+	+	+	+	6	10	5	+	+	+

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 6000 DAYS PARTICLES = 285
CONCENTRATION MAP IN PPM

0211235

J

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
14	+	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	2	6	3	+	+	+	+	+	+
10	+	+	+	18	20	+	2	+	+	+	+
9	+	+	+	+	120	34	2	+	+	+	+
8	+	+	+	4	68	151	8	+	+	+	+
7	+	+	+	10	29	208	+	8	+	+	+
6	+	+	+	+	+	58	6	6	+	+	+
5	+	+	+	+	+	4	+	+	+	+	+
4	+	+	+	+	+	17	22	11	+	+	+

RD30-164

T= 16 years

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

//////////////////////PARTICLES\\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
LINE NUMBER 1
LINE COORDINATES:
BEGINNING POINT (I,J) = 15 , 4 GRID
END POINT OF LINE (I,J) = 17 , 4 GRID
NUMBER OF PARTICLES = 3
SYSTEM PARTICLES = 288
PARTICLES ON A LINE
LINE NUMBER 2
LINE COORDINATES:
BEGINNING POINT (I,J) = 15 , 7 GRID
END POINT OF LINE (I,J) = 15 , 7 GRID
NUMBER OF PARTICLES = 60
SYSTEM PARTICLES = 348
PARTICLES ON A LINE
LINE NUMBER 3
LINE COORDINATES:
BEGINNING POINT (I,J) = 1 , 1 GRID
END POINT OF LINE (I,J) = 1 , 1 GRID
NUMBER OF PARTICLES = 1

TOTAL SYSTEM PARTICLES = 348
\\\\\\\\\\\\\\\\\\\\///////////////////////
PRESENT SIMULATION TIME = 6000 DAYS
INCREMENTAL SIMULATION TIME = 1000 DAYS
DMAX = 200 FT

NP = 348

ACCUMULATED TIME = 7000 DAYS PARTICLES = 348
x PARTICLE MAP

COORDINATES ARE IN FEET

K

```
      -------------------------------------------
14 |  +  +  +  +  +  +  +  +  +  +  +
13 |  +  +  +  +  +  +  +  +  +  +  +
12 |  +  +  +  3  +  +  +  +  +  +  +
11 |  +  +  1  8  +  +  +  +  +  +  +
10 |  +  +  + 13 29  1  +  +  +  +  +
9  |  +  +  +  2 55 15  2  1  +  +  +
8  |  +  +  +  1 23 75  3  2  +  +  +
7  |  +  +  +  +  2 49  +  +  +  +  +
6  |  + -+  +  +  2  9  3  1  +  +  +
5  |  +  +  +  +  +  4  1  2  +  +  +
4  |  +  +  +  +  +  4 10  5  +  +  +
      -------------------------------------------

      1  1  1  1  1  1  1  1  1  1  2
      0  1  2  3  4  5  6  7  8  9  0
```

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7000 DAYS PARTICLES = 348

X CONCENTRATION MAP IN PPM

```
------------------------------

       COORDINATES ARE IN FEET
      -------------------------------------------
14 |  +  +  +  +  +  +  +  +  +  +  +
13 |  +  +  +  +  +  +  +  +  +  +  +
12 |  +  +  +  4  +  +  +  +  +  +  +
11 |  +  +  2 13  +  +  +  +  +  +  +
10 |  +  +  + 27 53  2  +  +  +  +  +
9  |  +  +  +  5 132 32  4  2  +  +  +
8  |  +  +  +  4 74 206  8  5  +  +  +
7  |  +  +  +  + 11 217  +  +  +  +  +
6  |  +  +  +  + 22 65 18  6  +  +  +
5  |  +  +  +  +  + 17  3  7  +  +  +
4  |  +  +  +  +  + 11 22 11  +  +  +
      -------------------------------------------

      1  1  1  1  1  1  1  1  1  1  2
      0  1  2  3  4  5  6  7  8  9  0
```

RD30-194

T= 19 years

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
    /////////////////////PARTICLES\\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
   LINE NUMBER 1
        LINE COORDINATES:
        BEGINNING POINT (I,J) =  15 , 4  GRID
        END POINT OF LINE (I,J) =  17 , 4  GRID
        NUMBER OF PARTICLES =  8
     SYSTEM PARTICLES =  356
PARTICLES ON A LINE
   LINE NUMBER 2
        LINE COORDINATES:
        BEGINNING POINT (I,J) =  15 , 7  GRID
        END POINT OF LINE (I,J) =  15 , 7  GRID
        NUMBER OF PARTICLES =  60
     SYSTEM PARTICLES =  416

       TOTAL SYSTEM PARTICLES =  416
    ...........................................
```

\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\//

PRESENT SIMULATION TIME = 7000 DAYS

INCREMENTAL SIMULATION TIME = 1000 DAYS

DMAX = 200 FT

NP = 416

ACCUMULATED TIME = 8000 DAYS PARTICLES = 416

PARTICLE MAP

COORDINATES ARE IN FEET

14	+	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	5	2	+	+	+	+	+	+	+
11	+	+	1	14	1	+	+	+	+	+	+
10	+	+	+	27	31	2	+	+	+	+	+
9	+	+	+	1	69	17	2	1	1	+	+
8	+	+	+	2	29	84	4	1	+	+	+
7	+	+	+	+	5	50	5	1	+	+	+
6	+	+	+	+	1	8	1	2	+	+	+
5	+	+	+	+	+	4	1	+	+	+	+
4	+	+	+	+	+	6	11	4	+	+	+
	10	11	12	13	14	15	16	17	18	19	20

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 8000 DAYS PARTICLES = 416

CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

14	+	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	7	3	+	+	+	+	+	+	+
11	+	+	2	23	1	+	+	+	+	+	+
10	+	+	+	55	57	3	+	+	+	+	+
9	+	+	+	3	165	36	4	2	2	+	+
8	+	+	+	8	93	231	10	2	+	+	+
7	+	+	+	+	29	221	20	4	+	+	+
6	+	+	+	+	11	58	6	13	+	+	+
5	+	+	+	+	+	17	3	+	+	+	+
4	+	+	+	+	+	17	24	9	+	+	+
	10	11	12	13	14	15	16	17	18	19	20

RD30-224

T= 22 years

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

• DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

M

```
////////////////////PARTICLES\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
   LINE NUMBER 1
        LINE COORDINATES:
        BEGINNING POINT (I,J) =  15 , 4  GRID
        END POINT OF LINE (I,J) =  17 , 4  GRID
        NUMBER OF PARTICLES =  8
    SYSTEM PARTICLES =  424
PARTICLES ON A LINE
   LINE NUMBER 2
        LINE COORDINATES:
        BEGINNING POINT (I,J) =  15 , 7  GRID
        END POINT OF LINE (I,J) =  15 , 7  GRID
        NUMBER OF PARTICLES =  70
    SYSTEM PARTICLES =  494

      TOTAL SYSTEM PARTICLES =  494
     \\\\\\\\\\\\\\\\\\\\\\\/////////////////////////
     PRESENT SIMULATION TIME =  8000   DAYS
      INCREMENTAL SIMULATION TIME =  1125  DAYS
DMAX =  200  FT

NP =  494
```

```
ACCUMULATED TIME =  9125  DAYS      PARTICLES =  494
PARTICLE MAP
------------------------------
        COORDINATES ARE IN FEET
     -----------------------------------------
14 |  +   +   +   +   +   +   +   +   +   +   +
13 |  +   +   1   +   +   +   +   +   +   +   +
12 |  +   +  10   1   +   +   +   +   +   +   +
11 |  +   +   5  28   +   +   +   +   +   +   +
10 |  +   +   +  32  41   6   1   +   +   +   +
9  |  +   +   +   4  78  25   3   3   1   +   +
8  |  +   +   +   2  28  84   +   +   +   +   +
7  |  +   +   +   +   3  59   7   3   +   +   +
6  |  +   +   +   +   5   9   +   +   +   +   +
5  |  +   +   +   +   1   6   +   +   +   +   +
4  |  +   +   +   +   +   4  20   7   +   +   +
     -----------------------------------------

      1   1   1   1   1   1   1   1   1   1   2
      0   1   2   3   4   5   6   7   8   9   0
```

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

0211239

```
ACCUMULATED TIME =  9125  DAYS      PARTICLES =  494
CONCENTRATION MAP IN PPM
------------------------------

        COORDINATES ARE IN FEET
     ------------------------------------------
14 |  +   +   +   +   +   +   +   +   +   +   +
13 |  +   +   1   +   +   +   +   +   +   +   +
12 |  +   +  14   1   +   +   +   +   +   +   +
11 |  +   +   9  45   +   +   +   +   +   +   +
10 |  +   +   +  65  76  10   2   +   +   +   +
9  |  +   +   +  11 187  54   6   6   2   +   +
8  |  +   +   +   8  90 231   +   +   +   +   +
7  |  +   +   +   +  17 261  27  12   +   +   +
6  |  +   +   +   +  54  65   +   +   +   +   +
5  |  +   +   +   +   8  26   +   +   +   +   +
4  |  +   +   +   +   +  11  44  16   +   +   +
     ------------------------------------------

      1   1   1   1   1   1   1   1   1   1   2
      0   1   2   3   4   5   6   7   8   9   0
```

RD30-25Y

T= 25 years

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

There are 23 sinks

Sink #	I coordinate	J coordinate	Withdrawal rate
1	1	30	1
2	2	30	1
3	3	30	1
4	4	30	1
5	5	30	1
6	6	30	1
7	7	30	1
8	8	30	1
9	9	30	1
10	10	30	1
11	11	30	1
12	12	30	1
13	13	30	1
14	14	30	1
15	15	30	1
16	16	30	1
17	17	30	1
18	18	4	93260.75
19	18	5	34330.08
20	18	6	22517.58
21	18	30	1
22	19	30	1
23	20	30	1

(ADD MORE TIME)

STARTING TIME OF SIMULATIN (DAYS) = 0

////////////////////PARTICLES\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
  LINE NUMBER 1
    LINE COORDINATES:
    BEGINNING POINT (I,J) = 15 , 4 GRID
    END POINT OF LINE (I,J) = 17 , 4 GRID
    NUMBER OF PARTICLES = 3
  SYSTEM PARTICLES = 497

0211240

PARTICLES ON A LINE
LINE NUMBER 2
LINE COORDINATES:
BEGINNING POINT (I,J) = 15 , 7 GRID
END POINT OF LINE (I,J) = 15 , 7 GRID
NUMBER OF PARTICLES = 70
SYSTEM PARTICLES = 567

TOTAL SYSTEM PARTICLES = 567

\\//////////////////////////////

PRESENT SIMULATION TIME = 0 DAYS
INCREMENTAL SIMULATION TIME = 1000 DAYS
DMAX = 200 FT

NP = 566
CONCENTRATION IN PUMPED WELL NUMBER 18 , IN PPM, IS = 3.856027

ACCUMULATED TIME = 1000 DAYS PARTICLES = 566
PARTICLE MAP

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
14	+	+	+	+	+	+	+	+	+	+	+
13	+	1	3	+	+	+	+	+	+	+	+
12	+	1	13	2	+	+	1	+	+	+	+
11	+	+	11	26	3	+	+	+	+	+	+
10	+	+	1	39	48	3	6	+	1	+	+
9	+	+	+	4	89	36	2	+	+	+	+
8	+	+	+	3	38	85	3	+	+	+	+
7	+	+	+	+	10	58	5	1	+	+	+
6	+	+	+	+	3	16	4	1	+	+	+
5	+	+	+	+	+	1	+	+	+	+	+
4	+	+	+	+	+	3	20	5	+	+	+

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 1000 DAYS PARTICLES = 566
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

14	+	+	+	+	+	+	+	+	+	+	+
13	+	1	4	+	+	+	+	+	+	+	+
12	+	2	19	3	+	+	1	+	+	+	+
11	+	+	19	42	4	+	+	+	+	+	+
10	+	+	2	80	88	5	9	+	2	+	+
9	+	+	+	11	213	77	4	+	+	+	+
8	+	+	+	12	122	233	8	+	+	+	+
7	+	+	+	+	57	257	20	4	+	+	+

RD30-284
T = 28 years

```
 6 |  +  +  +  + 32 115 24  6  +  +  +
 5 |  +  +  +  +  +  4  +  +  +  +  +
 4 |  +  +  +  +  +  8 44 11  +  +  +
     -------------------------------------------

      1  1  1  1  1  1  1  1  1  1  2
      0  1  2  3  4  5  6  7  8  9  0
```

P

```
DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.
```

```
   ////////////////////PARTICLES\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
   LINE NUMBER 1
        LINE COORDINATES:
        BEGINNING POINT (I,J) =  15 , 7  GRID
        END POINT OF LINE (I,J) =  15 , 7  GRID
        NUMBER OF PARTICLES =  90
     SYSTEM PARTICLES =  656
PARTICLES ON A LINE
   LINE NUMBER 2
        LINE COORDINATES:
        BEGINNING POINT (I,J) =  15 , 4  GRID
        END POINT OF LINE (I,J) =  17 , 4  GRID
        NUMBER OF PARTICLES =  1
     SYSTEM PARTICLES =  657

       TOTAL SYSTEM PARTICLES =  657
    \\\\\\\\\\\\\\\\\\\\////////////////////////
    PRESENT SIMULATION TIME =  1000   DAYS
     INCREMENTAL SIMULATION TIME =  825  DAYS
DMAX =  200  FT

NP =  656
CONCENTRATION IN PUMPED WELL NUMBER  18 . IN PPM. IS =  4.673973
```

```
ACCUMULATED TIME =  1825  DAYS      PARTICLES =  656
PARTICLE MAP
------------------------------
       COORDINATES ARE IN FEET
     -------------------------------------------
14 |  +  2  +  +  +  +  +  +  +  +  +
13 |  +  1  5  +  +  +  +  +  +  +  +
12 |  +  1 18  4  +  +  1  +  +  +  +
11 |  +  + 12 38  1  +  +  +  +  +  +
10 |  +  +  + 35 50  6  5  +  1  +  +
 9 |  +  +  2  3 115 37 2  1  +  +  +
 8 |  +  +  +  3 30 117 6  1  +  +  +
 7 |  +  +  +  +  8 70  3  1  +  +  +
 6 |  +  +  +  +  3 21  2  1  +  +  +
 5 |  +  +  +  +  +  3  +  1  +  +  +
 4 |  +  +  +  +  +  2 21  2  +  +  +
     -------------------------------------------

      1  1  1  1  1  1  1  1  1  1  2
```

0 1 2 3 4 5 6 7 8 9 0

Q

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 1825 DAYS PARTICLES = 656

X CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
14	+	2	+	+	+	+	+	+	+	+	+
13	+	1	6	+	+	+	+	+	+	+	+
12	+	2	26	5	+	+	1	+	+	+	+
11	+	+	21	62	1	+	+	+	+	+	+
10	+	+	+	71	92	10	8	+	2	+	+
9	+	+	6	8	276	79	4	2	+	+	+
8	+	+	+	12	97	321	15	2	+	+	+
7	+	+	+	+	46	310	12	4	+	+	+
6	+	+	+	+	32	152	12	6	+	+	+
5	+	+	+	+	+	13	+	4	+	+	+
4	+	+	+	+	+	6	46	4	+	+	+

RD 30-30Y

T = 30 years

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

PRESENT SIMULATION TIME = 1825 DAYS
INCREMENTAL SIMULATION TIME = 365 DAYS
DMAX = 200 FT

NP = 656

ACCUMULATED TIME = 2190 DAYS PARTICLES = 656

X PARTICLE MAP

COORDINATES ARE IN FEET

14	+	2	+	+	+	+	+	+	+	+	+
13	+	2	5	+	+	+	1	+	+	+	+
12	+	2	26	2	+	+	+	+	+	+	+
11	+	+	13	31	2	+	+	+	+	+	+
10	+	+	1	43	61	6	6	+	1	+	+
9	+	+	2	3	108	41	1	2	+	+	+
8	+	+	+	5	31	103	4	2	+	+	+
7	+	+	+	+	12	67	2	+	+	+	+
6	+	+	+	+	1	15	1	1	+	+	+
5	+	+	+	+	+	3	2	+	+	+	+
4	+	+	+	+	+	4	20	3	+	+	+

0211243

R

1	1	1	1	1	1	1	1	1	1	2
0	1	2	3	4	5	6	7	8	9	0

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 2190 DAYS   PARTICLES = 656

X CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
14	+	2	+	+	+	+	+	+	+	+	+
13	+	3	6	+	+	+	1	+	+	+	+
12	+	3	38	3	+	+	+	+	+	+	+
11	+	+	23	50	3	+	+	+	+	+	+
10	+	+	2	88	112	10	9	+	2	+	+
9	+	+	6	8	259	88	2	4	+	+	+
8	+	+	+	20	100	283	10	5	+	+	+
7	+	+	+	+	69	297	8	+	+	+	+
6	+	+	+	+	11	108	6	6	+	+	+
5	+	+	+	+	+	13	7	+	+	+	+
4	+	+	+	+	+	11	44	7	+	+	+

R D30-31Y

T = 31 years

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 2190 DAYS   PARTICLES = 656

Y PARTICLE MAP

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
16	+	+	+	+	+	+	+	+	+	+	+
15	+	+	+	+	+	+	+	+	+	+	+
14	+	2	+	+	+	+	+	+	+	+	+
13	+	2	5	+	+	+	1	+	+	+	+
12	+	2	26	2	+	+	+	+	+	+	+
11	+	+	13	31	2	+	+	+	+	+	+
10	+	+	1	43	61	6	6	+	1	+	+
9	+	+	2	3	108	41	1	2	+	+	+
8	+	+	+	5	31	103	4	2	+	+	+
7	+	+	+	+	12	67	2	+	+	+	+
6	+	+	+	+	1	15	1	1	+	+	+

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 2190 DAYS   PARTICLES = 656

PARTICLE MAP

5

COORDINATES ARE IN FEET

11	+	+	13	31	2	+	+	+	+	+	+
10	+	+	1	43	61	6	6	+	1	+	+
9	+	+	2	3	108	41	1	2	+	+	+
8	+	+	+	5	31	103	4	2	+	+	+
7	+	+	+	+	12	67	2	+	+	+	+
6	+	+	+	+	1	15	1	1	+	+	+
5	+	+	+	+	+	3	2	+	+	+	+
4	+	+	+	+	+	4	20	3	+	+	+
3	+	+	+	+	+	2	7	7	+	+	+
2	+	+	+	+	+	1	1	+	+	+	+
1	+	+	+	+	+	1	+	+	+	+	+
	1	1	1	1	1	1	1	1	1	1	2
	0	1	2	3	4	5	6	7	8	9	0

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 2190 DAYS PARTICLES = 656
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

11	+	+	23	50	3	+	+	+	+	+	+
10	+	+	2	88	112	10	9	+	2	+	+
9	+	+	6	8	259	88	2	4	+	+	+
8	+	+	+	20	100	283	10	5	+	+	+
7	+	+	+	+	69	297	8	+	+	+	+
6	+	+	+	+	11	108	6	6	+	+	+
5	+	+	+	+	+	13	7	+	+	+	+
4	+	+	+	+	+	11	44	7	+	+	+
3	+	+	+	+	+	6	19	19	+	+	+
2	+	+	+	+	+	3	3	+	+	+	+
1	+	+	+	+	+	11	+	+	+	+	+
	1	1	1	1	1	1	1	1	1	1	2
	0	1	2	3	4	5	6	7	8	9	0

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

END

0211245

500 YEAR ARSENIC TRANSPORT SIMULATION (100 YEAR INCREMENTS)

A

T= 0 yr.

ACCUMULATED TIME = ~~2190 DAYS~~ 31 yr   PARTICLES = 656

CONCENTRATION MAP IN PPM

```
-----------------------------
           COORDINATES ARE IN FEET
      -------------------------------------------
11  |  +   +   +   +   +   +   +   +   +   +   +
10  |  +   +   +   +   +   +   +   +   +   +   +
9   |  +   +   +   +   +   +   +   +   +   +   +
8   |  +   +   +   +   +   +   +   +   +   +   +
7   |  +   +   +   +   +   +   +   +   +   +   +
6   |  +   +   +   +   +   +   +   +   +   +   +
5   |  +   +   +   +   +   +   +   +   +   +   +
4   |  +   +   +   +   +   +   +   +   +   +   +
3   |  +   +   +   +   +   +   +   +   +   +   +
2   |  +   +   +   +   +   +   +   +   +   +   +
1   |  +   +   +   +   +   +   +   +   +   +   +
      -------------------------------------------

       1   2   3   4   5   6   7   8   9   1   1
                                           0   1
```

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 2190 DAYS   PARTICLES = 656

CONCENTRATION MAP IN PPM

```
-----------------------------
           COORDINATES ARE IN FEET
      -------------------------------------------
11  |  +   +  23  50   3   +   +   +   +   +   +
10  |  +   +   2  88 112  10   9   +   2   +   +
9   |  +   +   6   8 259  88   2   4   +   +   +
8   |  +   +   +  20 100 283  10   5   +   +   +
7   |  +   +   +   +  69 297   8   +   +   +   +
6   |  +   +   +   +  11 108   6   6   +   +   +
5   |  +   +   +   +   +  13   7   +   +   +   +
4   |  +   +   +   +   +  11  44   7   +   +   +
3   |  +   +   +   +   +   6  19  19   +   +   +
2   |  +   +   +   +   +   3   3   +   +   +   +
1   |  +   +   +   +   +  11   +   +   +   +   +
      -------------------------------------------

       1   1   1   1   1   1   1   1   1   1   2
       0   1   2   3   4   5   6   7   8   9   0
```

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 2190 DAYS   PARTICLES = 656

CONCENTRATION MAP IN PPM

```
-----------------------------
           COORDINATES ARE IN FEET
      -------------------------------------------
20  |  +   +   +   +   +   +   +   +   +   +   +
```

0211247

B

```
19 I  +    +    +    +    +    +    +    +    +    +    +
18 I  +    +    +    +    +    +    +    +    +    +    +
17 I  +    +    +    +    +    +    +    +    +    +    +
16 I  +    +    +    +    +    +    +    +    +    +    +
15 I  +    +    +    +    +    +    +    +    +    +    +
14 I  +    +    +    +    +    +    +    +    +    +    2
13 I  +    +    +    +    +    +    +    +    +    +    3
12 I  +    +    +    +    +    +    +    +    +    +    3
11 I  +    +    +    +    +    +    +    +    +    +    +
10 I  +    +    +    +    +    +    +    +    +    +    +
     ------------------------------------------------

      1    2    3    4    5    6    7    8    9    1    1
                                                   0    1
```

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
ACCUMULATED TIME =  2190  DAYS        PARTICLES =  656
CONCENTRATION MAP IN PPM
------------------------------

           COORDINATES ARE IN FEET
     ------------------------------------------------
20 I  +    +    +    +    +    +    +    +    +    +    +
19 I  +    +    +    +    +    +    +    +    +    +    +
18 I  +    +    +    +    +    +    +    +    +    +    +
17 I  +    +    +    +    +    +    +    +    +    +    +
16 I  +    +    +    +    +    +    +    +    +    +    +
15 I  +    +    +    +    +    +    +    +    +    +    +
14 I  +    2    +    +    +    +    +    +    +    +    +
13 I  +    3    6    +    +    +    1    +    +    +    +
12 I  +    3   38    3    +    +    +    +    +    +    +
11 I  +    +   23   50    3    +    +    +    +    +    +
10 I  +    +    2   88  112   10    9    +    2    +    +
     ------------------------------------------------

      1    1    1    1    1    1    1    1    1    1    2
      0    1    2    3    4    5    6    7    8    9    0
```

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
ACCUMULATED TIME =  2190  DAYS        PARTICLES =  656
CONCENTRATION MAP IN PPM
------------------------------

           COORDINATES ARE IN FEET
     ------------------------------------------------
30 I  +    +    +    +    +    +    +    +    +    +    +
29 I  +    +    +    +    +    +    +    +    +    +    +
28 I  +    +    +    +    +    +    +    +    +    +    +
27 I  +    +    +    +    +    +    +    +    +    +    +
26 I  +    +    +    +    +    +    +    +    +    +    +
25 I  +    +    +    +    +    +    +    +    +    +    +
24 I  +    +    +    +    +    +    +    +    +    +    +
23 I  +    +    +    +    +    +    +    +    +    +    +
22 I  +    +    +    +    +    +    +    +    +    +    +
21 I  +    +    +    +    +    +    +    +    +    +    +
20 I  +    +    +    +    +    +    +    +    +    +    +
     ------------------------------------------------
```

cont.

0211248

1 2 3 4 5 6 7 8 9 1 1
0 1

c

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 2190 DAYS PARTICLES = 656
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

30	+	+	+	+	+	+	+	+	+	+	+
29	+	+	+	+	+	+	+	+	+	+	+
28	+	+	+	+	+	+	+	+	+	+	+
27	+	+	+	+	+	+	+	+	+	+	+
26	+	+	+	+	+	+	+	+	+	+	+
25	+	+	+	+	+	+	+	+	+	+	+
24	+	+	+	+	+	+	+	+	+	+	+
23	+	+	+	+	+	+	+	+	+	+	+
22	+	+	+	+	+	+	+	+	+	+	+
21	+	+	+	+	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+	+	+	+	+
	10	11	12	13	14	15	16	17	18	19	20

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

131 years

ACCUMULATED TIME = ~~7300 DAYS~~ PARTICLES = 654
CONCENTRATION MAP IN PPM

T= 100 yr.

COORDINATES ARE IN FEET

11	+	+	+	+	+	+	+	+	+	+	2
10	+	+	+	+	+	+	+	+	+	+	+
9	+	+	+	+	+	+	+	+	+	+	+
8	+	+	+	+	+	+	+	+	+	+	+
7	+	+	+	+	+	+	+	+	+	+	+
6	+	+	+	+	+	+	+	+	+	+	+
5	+	+	+	+	+	+	+	+	+	+	+
4	+	+	+	+	+	+	+	+	+	+	+
3	+	+	+	+	+	+	+	+	+	+	+
2	+	+	+	+	+	+	+	+	+	+	+
1	+	+	+	+	+	+	+	+	+	+	+
	1	2	3	4	5	6	7	8	9	10	11

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

D

ACCUMULATED TIME = 7300 DAYS PARTICLES = 654
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
11	+	2	2	5	1	4	+	+	+	+	+
10	+	+	+	2	2	+	2	+	+	+	+
9	+	+	+	3	+	+	4	+	+	+	+
8	+	+	+	+	3	+	5	+	+	+	+
7	+	+	+	+	6	+	4	+	+	+	+
6	+	+	+	+	+	+	+	+	+	+	+
5	+	+	+	+	16	+	+	+	+	+	+
4	+	+	+	+	+	+	2	+	+	+	+
3	+	+	+	+	+	+	5	3	+	+	+
2	+	+	+	+	+	+	+	+	+	+	+
1	+	+	+	+	+	32	11	11	+	+	+

Cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 654
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	1	2	3	4	5	6	7	8	9	10	11
20	+	+	+	+	+	5	7	3	+	+	+
19	+	+	+	+	+	5	20	12	1	+	+
18	+	+	+	+	+	1	13	24	11	+	+
17	+	+	+	+	+	+	10	41	38	7	1
16	+	+	+	+	+	+	4	14	41	28	6
15	+	+	+	+	+	+	1	2	21	38	10
14	+	+	+	+	+	+	+	+	6	24	34
13	+	+	+	+	+	+	+	+	+	4	13
12	+	+	+	+	+	+	+	+	+	2	8
11	+	+	+	+	+	+	+	+	+	+	2
10	+	+	+	+	+	+	+	+	+	+	+

Cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 654
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

20	+	+	+	+	+	+	+	3	1	+	+
19	+	+	+	+	+	+	+	3	1	1	+
18	+	+	+	+	+	+	1	1	1	+	+

E

	10	11	12	13	14	15	16	17	18	19	20
17	7	1	+	+	+	+	+	1	1	+	+
16	28	6	+	+	+	+	+	2	+	+	+
15	38	10	1	+	+	+	1	1	+	+	+
14	24	34	5	1	+	+	1	3	1	+	+
13	4	13	11	1	+	+	1	+	+	+	+
12	2	8	10	1	1	+	1	+	+	+	+
11	+	2	2	5	1	4	+	+	+	+	+
10	+	+	+	2	2	+	2	+	+	+	+

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 654
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	1	2	3	4	5	6	7	8	9	10	11
30	+	+	+	+	+	+	+	+	+	+	+
29	+	+	+	+	+	+	+	+	+	+	+
28	+	+	+	+	+	+	+	+	+	+	+
27	+	+	+	+	+	+	+	+	+	+	+
26	+	+	+	+	+	+	+	+	+	+	+
25	+	+	+	+	+	+	+	+	+	+	+
24	+	+	+	+	+	+	+	+	+	+	+
23	+	+	+	+	+	+	+	+	+	+	+
22	+	+	+	+	+	1	+	+	+	+	+
21	+	+	+	+	1	3	2	+	+	+	+
20	+	+	+	+	+	5	7	3	+	+	+

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 654
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
30	+	+	+	+	+	+	+	+	+	+	+
29	+	+	+	+	+	+	+	+	+	+	+
28	+	+	+	+	+	+	+	+	+	+	+
27	+	+	+	+	+	+	+	+	+	+	+
26	+	+	+	+	+	+	+	+	+	+	+
25	+	+	+	+	+	+	+	+	+	+	+
24	+	+	+	+	+	+	+	+	+	+	+
23	+	+	+	+	+	+	+	+	+	+	+
22	+	+	+	+	+	+	+	+	+	+	+
21	+	+	+	+	+	+	+	2	+	+	+
20	+	+	+	+	+	+	+	3	1	+	+

cont.

0211251

F

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

---

231 years

ACCUMULATED TIME = ~~7300 DAYS~~ PARTICLES = 653

T= 200 yr.

CONCENTRATION MAP IN PPM

```
------------------------------
          COORDINATES ARE IN FEET
      ------------------------------------------
 11  I  +   +   +   +   +   +   +   +   +   +   +
 10  I  +   +   +   +   +   +   +   +   +   +   +
 9   I  +   +   +   +   +   +   +   +   +   +   +
 8   I  +   +   +   +   +   +   +   +   +   +   +
 7   I  +   +   +   +   +   +   +   +   +   +   +
 6   I  +   +   +   +   +   +   +   +   +   +   +
 5   I  +   +   +   +   +   +   +   +   +   +   +
 4   I  +   +   +   +   +   +   +   +   +   +   +
 3   I  +   +   +   +   +   +   +   +   +   +   +
 2   I  +   +   +   +   +   +   +   +   +   +   +
 1   I  +   +   +   +   +   +   +   +   +   +   +
      ------------------------------------------

        1   2   3   4   5   6   7   8   9   1   1
                                            0   1
```

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 653

CONCENTRATION MAP IN PPM

```
------------------------------
          COORDINATES ARE IN FEET
      ------------------------------------------
 11  I  +   +   +   +   +   +   +   +   +   +   +
 10  I  +   +   +   +   +   +   +   +   +   +   +
 9   I  +   +   +   +   +   +   +   +   +   +   +
 8   I  +   +   +   +   +   +   +   +   +   +   +
 7   I  +   +   +   +   +   +   +   +   +   +   +
 6   I  +   +   +   +   +   +   +   +   +   +   +
 5   I  +   +   +   +   8   +   +   +   +   +   +
 4   I  +   +   +   +   +   +   2   +   +   +   +
 3   I  +   +   +   +   +   +   +   +   +   +   +
 2   I  +   +   +   +   +   +   +   +   +   +   +
 1   I  +   +   +   +   +  32  21  11   +   +   +
      ------------------------------------------

        1   1   1   1   1   1   1   1   1   1   2
        0   1   2   3   4   5   6   7   8   9   0
```

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

6

ACCUMULATED TIME = 7300 DAYS PARTICLES = 653
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	1	2	3	4	5	6	7	8	9	10	11
20	+	+	+	+	9	19	24	7	2	+	+
19	+	+	+	1	+	18	23	13	1	+	+
18	+	+	+	+	+	3	12	13	6	+	+
17	+	+	+	+	+	1	8	9	5	1	1
16	+	+	+	+	+	+	1	4	3	6	1
15	+	+	+	+	+	+	+	+	2	1	4
14	+	+	+	+	+	+	+	+	+	1	2
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+	+

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 653
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
20	+	+	+	+	+	+	+	1	1	+	+
19	+	+	+	+	+	+	+	1	+	1	+
18	+	+	+	+	+	+	+	+	1	+	+
17	1	1	+	+	+	+	+	+	+	+	+
16	6	1	1	+	+	+	+	+	+	+	+
15	1	4	1	+	+	+	+	+	1	+	+
14	1	2	+	+	+	+	+	+	+	+	+
13	+	+	1	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+	+

Cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 653
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

30	+	+	+	+	+	+	+	+	+	+	+
29	+	+	+	+	+	+	+	+	+	+	+
28	+	+	+	+	1	+	+	+	+	+	+
27	+	+	+	+	+	+	+	+	+	+	+

0211253

	1	2	3	4	5	6	7	8	9	10	11
26	+	+	+	1	2	+	1	+	+	+	+
25	+	+	+	3	2	1	+	+	+	+	+
24	+	+	1	4	4	+	+	+	+	+	+
23	+	+	+	5	14	4	+	+	+	+	+
22	+	+	+	3	14	12	1	+	+	+	+
21	+	+	+	4	11	31	9	2	+	+	+
20	+	+	+	+	9	19	24	7	2	+	+

cont.

H

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 653
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
30	+	+	+	+	+	+	+	+	+	+	+
29	+	+	+	+	+	+	+	+	+	+	+
28	+	+	+	+	+	+	+	1	1	+	+
27	+	+	+	+	+	+	+	1	1	+	+
26	+	+	+	+	+	+	+	1	+	+	+
25	+	+	+	+	+	+	+	1	+	+	+
24	+	+	+	+	+	+	+	1	+	+	+
23	+	+	+	+	+	+	+	1	1	+	+
22	+	+	+	+	+	+	+	1	+	+	+
21	+	+	+	+	+	+	+	1	1	1	+
20	+	+	+	+	+	+	+	1	1	+	+

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

---

331 years

T= 300 yr.

ACCUMULATED TIME = ~~7300 DAYS~~ PARTICLES = 597
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

11	+	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+	+
9	+	+	+	+	+	+	+	+	+	+	+
8	+	+	+	+	+	+	+	+	+	+	+
7	+	+	+	+	+	+	+	+	+	+	+
6	+	+	+	+	+	+	+	+	+	+	+
5	+	+	+	+	+	+	+	+	+	+	+

0211254

I

```
 4  |  +   +   +   +   +   +   +   +   +   +   +
 3  |  +   +   +   +   +   +   +   +   +   +   +
 2  |  +   +   +   +   +   +   +   +   +   +   +
 1  |  +   +   +   +   +   +   +   +   +   +   +
      -----------------------------------------

       1   2   3   4   5   6   7   8   9   1   1
                                            0   1
```

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
ACCUMULATED TIME =  7300  DAYS       PARTICLES =  597
CONCENTRATION MAP IN PPM
----------------------------
           COORDINATES ARE IN FEET
      -----------------------------------------
11  |  +   +   +   +   +   +   +   +   +   +   +
10  |  +   +   +   +   +   +   +   +   +   +   +
 9  |  +   +   +   +   +   +   +   +   +   +   +
 8  |  +   +   +   +   +   +   +   +   +   +   +
 7  |  +   +   +   +   +   +   +   +   +   +   +
 6  |  +   +   +   +   +   +   +   +   +   +   +
 5  |  +   +   +   +   +   +   +   +   +   +   +
 4  |  +   +   +   +   +   +   +   +   +   +   +
 3  |  +   +   +   +   +   +   +   +   +   +   +
 2  |  +   +   +   +   +   +   +   +   +   +   +
 1  |  +   +   +   +   +  32  21  11   +   +   +
      -----------------------------------------

       1   1   1   1   1   1   1   1   1   1   2
       0   1   2   3   4   5   6   7   8   9   0
```

Cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
ACCUMULATED TIME =  7300  DAYS       PARTICLES =  597
CONCENTRATION MAP IN PPM
----------------------------
           COORDINATES ARE IN FEET
      -----------------------------------------
20  |  +   +   +   1   2   8   4   +   +   +   +
19  |  +   +   +   1   1   3   5   5   +   1   +
18  |  +   +   +   +   1   1   5   3   3   +   +
17  |  +   +   +   +   +   1   +   2   2   +   +
16  |  +   +   +   +   +   +   +   +   1   1   +
15  |  +   +   +   +   +   +   +   +   1   +   +
14  |  +   +   +   +   +   +   +   +   +   +   +
13  |  +   +   +   +   +   +   +   +   +   1   +
12  |  +   +   +   +   +   +   +   +   +   +   +
11  |  +   +   +   +   +   +   +   +   +   +   +
10  |  +   +   +   +   +   +   +   +   +   +   +
      -----------------------------------------

       1   2   3   4   5   6   7   8   9   1   1
                                            0   1
```

Cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

5

ACCUMULATED TIME = 7300 DAYS PARTICLES = 597
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

20	+	+	+	+	+	+	+	+	1	+	+
19	1	+	+	+	+	+	+	+	+	+	+
18	+	+	+	+	+	+	+	+	+	+	+
17	+	+	+	+	+	+	+	+	+	+	+
16	1	+	+	+	+	+	+	+	+	+	+
15	+	+	+	+	+	+	+	+	+	+	+
14	+	+	+	+	+	+	+	+	+	+	+
13	1	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+	+
	10	11	12	13	14	15	16	17	18	19	20

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 597
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

30	+	+	+	+	+	+	+	+	+	+	+
29	+	+	+	3	3	1	+	+	+	+	+
28	+	+	1	3	3	4	1	+	+	+	+
27	+	+	1	1	5	3	+	+	+	+	+
26	+	+	1	5	6	1	1	+	+	+	+
25	+	+	5	10	6	4	+	+	+	+	+
24	+	+	4	19	10	2	1	+	+	+	+
23	+	+	2	11	15	1	1	+	1	+	+
22	+	+	+	6	14	8	1	+	+	+	+
21	+	+	+	2	12	13	4	1	+	+	+
20	+	+	+	1	2	8	4	+	+	+	+
	1	2	3	4	5	6	7	8	9	10	11

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 597
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

30	+	+	+	+	+	+	+	+	+	+	+
29	+	+	+	+	+	+	+	1	+	+	+
28	+	+	+	+	+	+	+	+	1	+	+
27	+	+	+	+	+	+	+	+	+	+	+

cont.

x

	10	11	12	13	14	15	16	17	18	19	20
26	+	+	+	+	+	+	+	+	1	+	+
25	+	+	+	+	+	+	+	+	+	+	+
24	+	+	+	+	+	+	+	+	+	+	+
23	+	+	+	+	+	+	+	+	1	+	+
22	+	+	+	+	+	+	+	+	+	+	+
21	+	+	+	+	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+	+	1	+	+

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

431 years

ACCUMULATED TIME = ~~7300 DAYS~~ PARTICLES = 401

CONCENTRATION MAP IN PPM

T= 400 yr.

COORDINATES ARE IN FEET

	1	2	3	4	5	6	7	8	9	10	11
11	+	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+	+
9	+	+	+	+	+	+	+	+	+	+	+
8	+	+	+	+	+	+	+	+	+	+	+
7	+	+	+	+	+	+	+	+	+	+	+
6	+	+	+	+	+	+	+	+	+	+	+
5	+	+	+	+	+	+	+	+	+	+	+
4	+	+	+	+	+	+	+	+	+	+	+
3	+	+	+	+	+	+	+	+	+	+	+
2	+	+	+	+	+	+	+	+	+	+	+
1	+	+	+	+	+	+	+	+	+	+	+

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 401

CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
11	+	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+	+
9	+	+	+	+	+	+	+	+	+	+	+
8	+	+	+	+	+	+	+	+	+	+	+
7	+	+	+	+	+	+	+	+	+	+	+
6	+	+	+	+	+	+	+	+	+	+	+
5	+	+	+	+	+	+	+	+	+	+	+
4	+	+	+	+	+	+	+	+	+	+	+
3	+	+	+	+	+	+	+	+	+	+	+
2	+	+	+	+	+	+	+	+	+	+	+
1	+	+	+	+	+	32	21	11	+	+	+

Cont.

0211257

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 401
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

20	+	+	+	+	1	2	1	+	+	+	+
19	+	+	+	1	+	+	1	1	+	+	+
18	+	+	+	+	+	+	+	+	+	+	+
17	+	+	+	+	+	+	+	+	+	+	+
16	+	+	+	+	+	+	+	1	+	+	+
15	+	+	+	+	+	+	+	+	+	+	+
14	+	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+	+
	1	2	3	4	5	6	7	8	9	10	11

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 401
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

20	+	+	+	+	+	+	+	+	+	+	+
19	+	+	+	+	+	+	+	+	+	+	+
18	+	+	+	+	+	+	+	+	+	+	+
17	+	+	+	+	+	+	+	+	+	+	+
16	+	+	+	+	+	+	+	+	+	+	+
15	+	+	+	+	+	+	+	+	+	+	+
14	+	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+	+
	10	11	12	13	14	15	16	17	18	19	20

cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME = 7300 DAYS PARTICLES = 401
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

30	+	+	+	+	+	+	+	+	+	+	+

0211258

```
 5 | +  +  +  +  +  +  +  +  +  +  +
 4 | +  +  +  +  +  +  +  +  +  +  +
 3 | +  +  +  +  +  +  +  +  +  +  +
 2 | +  +  +  +  +  +  +  +  +  +  +
 1 | +  +  +  +  +  +  +  +  +  +  +
    ------------------------------------------

     1  2  3  4  5  6  7  8  9  1  1
                                0  1
```

Cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
ACCUMULATED TIME =  7300  DAYS      PARTICLES =  206
CONCENTRATION MAP IN PPM
-----------------------------
           COORDINATES ARE IN FEET
     ------------------------------------------
11 | +  +  +  +  +  +  +  +  +  +  +
10 | +  +  +  +  +  +  +  +  +  +  +
 9 | +  +  +  +  +  +  +  +  +  +  +
 8 | +  +  +  +  +  +  +  +  +  +  +
 7 | +  +  +  +  +  +  +  +  +  +  +
 6 | +  +  +  +  +  +  +  +  +  +  +
 5 | +  +  +  +  +  +  +  +  +  +  +
 4 | +  +  +  +  +  +  +  +  +  +  +
 3 | +  +  +  +  +  +  +  +  +  +  +
 2 | +  +  +  +  +  +  +  +  +  +  +
 1 | +  +  +  +  + 32 21 11  +  +  +
     ------------------------------------------

     1  1  1  1  1  1  1  1  1  1  2
     0  1  2  3  4  5  6  7  8  9  0
```

Cont.

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
ACCUMULATED TIME =  7300  DAYS      PARTICLES =  206
CONCENTRATION MAP IN PPM
-----------------------------
           COORDINATES ARE IN FEET
     ------------------------------------------
20 | +  +  +  +  +  +  +  1  +  +  +
19 | +  +  +  +  +  +  +  +  +  +  +
18 | +  +  +  +  +  +  +  +  +  +  +
17 | +  +  +  +  +  +  +  1  +  +  +
16 | +  +  +  +  +  +  +  +  +  +  +
15 | +  +  +  +  +  +  +  +  +  +  +
14 | +  +  +  +  +  +  +  +  +  +  +
13 | +  +  +  +  +  +  +  +  +  +  +
12 | +  +  +  +  +  +  +  +  +  +  +
11 | +  +  +  +  +  +  +  +  +  +  +
10 | +  +  +  +  +  +  +  +  +  +  +
     ------------------------------------------

     1  2  3  4  5  6  7  8  9  1  1
                                0  1
```

Cont.

0211259

```
DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME =  7300  DAYS        PARTICLES =  206
CONCENTRATION MAP IN PPM
-----------------------------

           COORDINATES ARE IN FEET
      -------------------------------------------
 20  |  +   +   +   +   +   +   +   +   +   +   +
 19  |  +   +   +   +   +   +   +   +   +   +   +
 18  |  +   +   +   +   +   +   +   +   +   +   +
 17  |  +   +   +   +   +   +   +   +   +   +   +
 16  |  +   +   +   +   +   +   +   +   +   +   +
 15  |  +   +   +   +   +   +   +   +   +   +   +
 14  |  +   +   +   +   +   +   +   +   +   +   +
 13  |  +   +   +   +   +   +   +   +   +   +   +
 12  |  +   +   +   +   +   +   +   +   +   +   +
 11  |  +   +   +   +   +   +   +   +   +   +   +
 10  |  +   +   +   +   +   +   +   +   +   +   +
      -------------------------------------------

         1   1   1   1   1   1   1   1   1   1   2
         0   1   2   3   4   5   6   7   8   9   0
```

cont.

```
DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME =  7300  DAYS        PARTICLES =  206
CONCENTRATION MAP IN PPM
-----------------------------

           COORDINATES ARE IN FEET
      -------------------------------------------
 30  |  +   +   +   +   +   +   +   +   +   +   +
 29  |  +   +   2   2   2   1   +   1   +   +   +
 28  |  +   +   3   3   3   2   +   +   +   +   +
 27  |  +   +   2   3   1   +   1   +   +   +   +
 26  |  +   1   3   4   1   1   +   +   +   +   +
 25  |  +   1   3   3   1   1   +   +   +   +   +
 24  |  +   +   3   5   1   +   +   +   +   +   +
 23  |  +   1   +   4   4   +   +   +   +   +   +
 22  |  +   +   +   +   1   +   +   +   +   +   +
 21  |  +   +   1   1   1   +   +   +   +   +   +
 20  |  +   +   +   +   +   +   +   1   +   +   +
      -------------------------------------------

         1   2   3   4   5   6   7   8   9   1   1
                                             0   1
```

cont.

```
DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

ACCUMULATED TIME =  7300  DAYS        PARTICLES =  206
CONCENTRATION MAP IN PPM
-----------------------------

           COORDINATES ARE IN FEET
      -------------------------------------------
 30  |  +   +   +   +   +   +   +   +   +   +   +
 29  |  +   +   +   +   +   +   +   +   +   +   +
 28  |  +   +   +   +   +   +   +   +   1   +   +
```

```
27 |  +    +    +    +    +    +    +    +    +    +    +
26 |  +    +    +    +    +    +    +    +    +    +    +
25 |  +    +    +    +    +    +    +    +    +    +    +
24 |  +    +    +    +    +    +    +    +    +    +    +
23 |  +    +    +    +    +    +    +    +    +    +    +
22 |  +    +    +    +    +    +    +    +    +    +    +
21 |  +    +    +    +    +    +    +    +    +    +    +
20 |  +    +    +    +    +    +    +    +    +    +    +
    -----------------------------------------------------

      1    1    1    1    1    1    1    1    1    1    2
      0    1    2    3    4    5    6    7    8    9    0
```

cnt

P

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

END

1.25 YEAR SULFATE TRANSPORT SIMULATION

A

//////////BASIC TRANSPORT COEFFICIENTS\\\\\\\\\\

POROSITY = .2
LONGITUDINAL DISPERSIVITY = 300
TRANSVERSE DISPERSIVITY (FT) = 5
RETARDATION COEFFICIENT = 1
PARTICLE MASS (LBS) = 1500

/////////////////////////\\\\\\\\\\\\\\\\\\\\\\\\\

There are 23 sinks

Sink #	I coordinate	J coordinate	Withdrawal rate
1	1	30	1
2	2	30	1
3	3	30	1
4	4	30	1
5	5	30	1
6	6	30	1
7	7	30	1
8	8	30	1
9	9	30	1
10	10	30	1
11	11	30	1
12	12	30	1
13	13	30	1
14	14	30	1
15	15	30	1
16	16	30	1
17	17	30	1
18	18	4	93260.75
19	18	5	34330.08
20	18	6	22517.58
21	18	30	1
22	19	30	1
23	20	30	1

STARTING TIME OF SIMULATIN (DAYS) = 0

//////////////////////PARTICLES\\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
LINE NUMBER 1
LINE COORDINATES:
BEGINNING POINT (I,J) = 15 , 7 GRID
END POINT OF LINE (I,J) = 15 , 7 GRID
NUMBER OF PARTICLES = 100
SYSTEM PARTICLES = 100
PARTICLES ON A LINE
LINE NUMBER 2
LINE COORDINATES:
BEGINNING POINT (I,J) = 15 , 4 GRID
END POINT OF LINE (I,J) = 17 , 4 GRID
NUMBER OF PARTICLES = 25
SYSTEM PARTICLES = 125

8

TOTAL SYSTEM PARTICLES = 125

\\////////////////////////

DO A SCR

/// ACCUMULATED TIME = 0 DAYS PARTICLES = 125

PARTICLE MAP

PARTICLE
LINE

COORDINATES ARE IN FEET

S
PARTICLE
LINE
S

14	+	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+	+
9	+	+	+	+	+	+	+	+	+	+	+
8	+	+	+	+	+	+	+	+	+	+	+
7	+	+	+	+	+	100	+	+	+	+	+
6	+	+	+	+	+	+	+	+	+	+	+
5	+	+	+	+	+	+	+	+	+	+	+
4	+	+	+	+	+	6	12	7	+	+	+
	10	11	12	13	14	15	16	17	18	19	20

\\

PR

I

DMAX =

NP = 27 DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

CONCENTR

PRESENT SIMULATION TIME = 0 DAYS

INCREMENTAL SIMULATION TIME = 90 DAYS

DMAX = 100 FT

NP = 124

CONCENTRATION IN PUMPED WELL NUMBER 19 , IN PPM. IS = 58.19581

ACCUMULA
CONCENTR

14 |
13 |
12 |
11 |
10 |
9 |
8 |
7 |
6 |
5 |
4 |

ACCUMULATED TIME = 90 DAYS PARTICLES = 124

CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

14	+	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+	+
11	+	+	+	24	+	+	+	+	+	+	+
10	+	+	+	92	194	25	23	+	+	+	+
9	+	+	+	+	935	225	+	29	+	+	+
8	+	+	+	+	290	906	+	+	+	+	+
7	+	+	+	+	+	1395	+	59	+	+	+
6	+	+	+	+	324	433	272	+	+	+	+
5	+	+	+	+	117	65	52	+	+	+	+
4	+	+	+	+	+	42	99	33	+	+	+

DO A SCR

```
          1    1    1    1    1    1    1    1    1    1    2
          0    1    2    3    4    5    6    7    8    9    0
```

c

```
DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

     /////////////////////PARTICLES\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
    LINE NUMBER 1
          LINE COORDINATES:
          BEGINNING POINT (I,J) =  15 , 7  GRID
          END POINT OF LINE (I,J) =  15 , 7  GRID
          NUMBER OF PARTICLES =  125
       SYSTEM PARTICLES =  249
PARTICLES ON A LINE
    LINE NUMBER 2
          LINE COORDINATES:
          BEGINNING POINT (I,J) =  15 , 4  GRID
          END POINT OF LINE (I,J) =  17 , 4  GRID
          NUMBER OF PARTICLES =  30
       SYSTEM PARTICLES =  279

         TOTAL SYSTEM PARTICLES =  279
      \\\\\\\\\\\\\\\\\\\\\///////////////////////
      PRESENT SIMULATION TIME =  90   DAYS
       INCREMENTAL SIMULATION TIME =  90  DAYS
DMAX =  100  FT

NP =  278
CONCENTRATION IN PUMPED WELL NUMBER  19 , IN PPM, IS =  58.19581
```

```
ACCUMULATED TIME =  180  DAYS       PARTICLES =  278
CONCENTRATION MAP IN PPM
------------------------------

           COORDINATES ARE IN FEET
      -------------------------------------------
 14  |    +    +    +    +    +    +    +    +    +    +    +
 13  |    +    +   18    +    +    +    +    +    +    +    +
 12  |    +    +    +    +    +    +    +    +    +    +    +
 11  |    +    +    + 316   22    +   20    +    +    +    +
 10  |    +    +    + 245 774     +    +    +    +    +    +
 9   |    +    +    +  412300 740 150   59    +    +    +
 8   |    +    +    +  61 7731812   75   37    +    +    +
 7   |    +    +    + 144 1721461 118  117    +    +    +
 6   |    +    +    +    +    + 866 272    +    +    +    +
 5   |    +    +    +    +    +  65    +    +    +    +    +
 4   |    +    +    +    +    + 126 198    +    +    +    +
      -------------------------------------------

          1    1    1    1    1    1    1    1    1    1    2
          0    1    2    3    4    5    6    7    8    9    0


DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.
```

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

D

```
      //////////////////////PARTICLES\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
    LINE NUMBER 1
          LINE COORDINATES:
          BEGINNING POINT (I,J) =  15 , 7  GRID
          END POINT OF LINE (I,J) =  15 , 7  GRID
          NUMBER OF PARTICLES =  150
     SYSTEM PARTICLES =  428
PARTICLES ON A LINE
    LINE NUMBER 2
          LINE COORDINATES:
          BEGINNING POINT (I,J) =  15 , 4  GRID
          END POINT OF LINE (I,J) =  17 , 4  GRID
          NUMBER OF PARTICLES =  35
     SYSTEM PARTICLES =  463

        TOTAL SYSTEM PARTICLES =  463
     \\\\\\\\\\\\\\\\\\\\/////////////////////////
      PRESENT SIMULATION TIME =  180   DAYS
       INCREMENTAL SIMULATION TIME =  90  DAYS
DMAX =  100  FT

NP =  463
```

```
ACCUMULATED TIME =  270  DAYS       PARTICLES =  463
CONCENTRATION MAP IN PPM
------------------------------

          COORDINATES ARE IN FEET
     ---------------------------------------------
 14  |   +   +   +   +   +   +   +   +   +   +   +
 13  |   +   +  54   +   +   +   +   +   +   +   +
 12  |   +  23 195  40   +   +  18   +   +   +   +
 11  |   +   +   + 681  67   +   +   +   +   +   +
 10  |   +   + 101 7971686 100  93  93   +   +   +
 9   |   +  55   + 163262 41030  60  29   +   +   +
 8   |   +   +   +   +12562677 263 183   +   +   +
 7   |   +   +   +   + 1722192 118  59   +   +   +
 6   |   +   +   +   +   +1082 272   +   +   +   +
 5   |   +   +   +   +   + 194 157  54   +   +   +
 4   |   +   +   +   +   + 252 264 100   +   +   +
     ---------------------------------------------

         1   1   1   1   1   1   1   1   1   1   2
         0   1   2   3   4   5   6   7   8   9   0
```

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

```
      //////////////////////PARTICLES\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
    LINE NUMBER 1
          LINE COORDINATES:
          BEGINNING POINT (I,J) =  15 , 7  GRID
```

E

```
          BEGINNING POINT (I,J) =  15 , 7  GRID
          END POINT OF LINE (I,J) =  15 . 7  GRID
          NUMBER OF PARTICLES =  175
       SYSTEM PARTICLES =  638
PARTICLES ON A LINE
    LINE NUMBER 2
          LINE COORDINATES:
          BEGINNING POINT (I,J) =  15 . 4  GRID
          END POINT OF LINE (I,J) =  17 , 4  GRID
          NUMBER OF PARTICLES =  40
       SYSTEM PARTICLES =  678

         TOTAL SYSTEM PARTICLES =  678
      \\\\\\\\\\\\\\\\\\\\\\////////////////////////
      PRESENT SIMULATION TIME =  270   DAYS
       INCREMENTAL SIMULATION TIME =  90  DAYS
DMAX =  100  FT

NP =  676
CONCENTRATION IN PUMPED WELL NUMBER  19 . IN PPM. IS =  116.3916




ACCUMULATED TIME =  360  DAYS       PARTICLES =  676
CONCENTRATION MAP IN PPM
------------------------------
          COORDINATES ARE IN FEET
      -------------------------------------------
 14  |   +  16   +   +   +   +   +  14   +   +   +
 13  |   +  77 127   +   +   +   +   +   +   +   +
 12  |   +  70 519 221   +   +   +   +   +   +   +
 11  |   +  29 1331314 155  20   +  21   +   +   +
 10  |   +  37   +14092433 150  93  93   +   +   +
 9   |   +   +   + 20439181223 180  59   +   +   +
 8   |   +   +   +   +12562924 301 219   +   +   +
 7   |   +   +   +   + 1722790 353 117   +   +   +
 6   |   +   +   +   + 324 974 363  94   +   +   +
 5   |   +   +   +   +   + 194 105  54   +   +   +
 4   |   +   +   +   +   + 252 396 200   +   +   +
      -------------------------------------------

         1   1   1   1   1   1   1   1   1   1   2
         0   1   2   3   4   5   6   7   8   9   0


DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

     /////////////////////PARTICLES\\\\\\\\\\\\\\\\\\\

PARTICLES ON A LINE
    LINE NUMBER 1
          LINE COORDINATES:
          BEGINNING POINT (I.J) =  15 . 7  GRID
          END POINT OF LINE (I,J) =  15 . 7  GRID
          NUMBER OF PARTICLES =  225
       SYSTEM PARTICLES =  901
PARTICLES ON A LINE
    LINE NUMBER 2
          LINE COORDINATES:
```

F

LINE COORDINATES:
BEGINNING POINT (I,J) = 15 , 4 GRID
END POINT OF LINE (I,J) = 17 , 4 GRID
NUMBER OF PARTICLES = 60
SYSTEM PARTICLES = 961

TOTAL SYSTEM PARTICLES = 961
\\////////////////////////
PRESENT SIMULATION TIME = 360 DAYS
INCREMENTAL SIMULATION TIME = 45 DAYS
DMAX = 100 FT

NP = 961

ACCUMULATED TIME = 405 DAYS PARTICLES = 961
CONCENTRATION MAP IN PPM

```
------------------------------
          COORDINATES ARE IN FEET
      ----------------------------------------------
14  |   +  49   +  15   +   +   +   +   +   +   +
13  |   + 154 218   +   +   +   +  16   +   +   +
12  |   +  70 995 262   +   +   +  18   +   +   +
11  |   +   + 2391800 377  20  20  62   +   +   +
10  |   +  37    +15322405 125 140  70  25   +   +
9   |   +   +   + 24540981770 180 117   +   +   +
8   |   +   +   +  6121265396 226 219   +   +   +
7   |   +   +   +   + 5166377 235 234   +   +   +
6   |   +   +   +   + 3242597 544 469   +   +   +
5   |   +   +   +   + 117 323   +  54   +   +   +
4   |   +   +   +   +   + 505 561 266   +   +   +
      ----------------------------------------------

        1   1   1   1   1   1   1   1   1   1   2
        0   1   2   3   4   5   6   7   8   9   0
```

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

PRESENT SIMULATION TIME = 405 DAYS
INCREMENTAL SIMULATION TIME = 45 DAYS
DMAX = 100 FT

NP = 961

ACCUMULATED TIME = 450 DAYS PARTICLES = 961
CONCENTRATION MAP IN PPM

COORDINATES ARE IN FEET

6

COORDINATES ARE IN FEET

	10	11	12	13	14	15	16	17	18	19	20
14	68	49	+	+	+	+	+	14	+	+	+
13	+	288	381	+	+	+	+	16	+	+	+
12	+	93	995	443	19	+	18	37	+	+	+
11	32	+	371	2359	443	+	61	42	22	+	+
10	+	+	+	1103	2820	426	116	70	+	+	+
9	+	+	+	449	4134	1673	150	147	+	+	+
8	+	+	+	121	1885	4489	301	219	36	+	+
7	+	+	+	144	430	3853	412	527	+	+	+
6	+	+	+	+	324	1515	181	94	+	+	+
5	+	+	+	+	+	65	157	54	+	+	+
4	+	+	+	+	+	252	429	200	+	+	+

DO A SCREEN PRINT NOW OR PRESS <RETURN> TO GO BACK TO THE MENU.

APPENDIX 9-1

OPERABLE UNIT ARARS

SURFACE WATER ARARs

A. Chemical-Specific ARARs

Federal

1. Safe Drinking Water Act, 42 U.S.C. § 300(f) et seq.

   a. 40 C.F.R. Part 141: National Primary Drinking Water Standards (MCLs)

Contaminant	Standard (mg/l)
Arsenic	0.05
Cadmium	0.010
Lead	0.05
Mercury	0.002
Selenium	0.01
Thallium	NA
[Zinc	NA]

   b. 40 C.F.R. Part 143: National Secondary Drinking Water Standards (SMCLS)

Contaminant	Standard (mg/l)
Copper	1.0
Iron	0.3
Manganese	0.05
[Zinc	5.0]

NB: Both Zinc and Silver were removed from the list of 83 contaminants listed under the SDWA. See 53 F.R. 1892, January 22, 1988.

   c. 40 C.F.R. Part 141: Maximum Contaminant Level Goals (MCLGs)

State

1. Montana Water Quality Act, M.C.A. § 75-5-101 et seq.
   Montana Public Water Supply Act, M.C.A. § 75-6-101 et seq.

   a. Public Water Supplies Regulations, A.R.M. § 16.20.203

Contaminant	MCL (mg/l)
Arsenic	0.05
Cadmium	0.010
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05

b. Montana Surface Water Quality Standards, A.R.M. § 16.20.623(2)

(c) Hydrogen ion concentration must be maintained within the range of 6.5 to 9.5.

(d) No increase in naturally occurring turbidity is allowed which will or is likely to create a nuisance or render the waters harmful, detrimental or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

(e) No increase in naturally occurring temperature is allowed which . . .

(h)(i) No discharges of toxic or deleterious substances may commence or continue which lower or are likely to lower the overall quality of these waters.

(iii) Beneficial uses are considered supported when the concentrations of toxic or deleterious substances in these waters do not exceed Gold Book levels . . .

(iv) Limits for toxic or deleterious substances . . . are the larger of either Gold Book levels or one-half of the mean in-stream concentrations immediately upstream of the discharge point.

c. "Gold Book" Levels

N.B. The Gold Book levels are set out in Quality Criteria for Water 1986 (EPA 440/5-86-001) and Update Number Two (5/1/87). Those levels are:

To Protect Aquatic Life

Contaminant	Acute	Levels (mg/l) Chronic
As(III)	0.36	0.19
As(IV)	0.85	0.048
Cd	0.0039	0.0011
Cu	0.018	0.012
Fe	----	1.0
Pb	0.082	0.0032
Hg	0.0024	0.000012
Se	0.28	0.036
Ag	0.0041	0.00012
Zn	0.12	0.11

To protect public health from ingestion of contaminated water and fish

Contaminant	Water/Fish	Fish
As	2.2 ng/l	17.5 ng/l
Cd	10.0 ug/l	----
Fe	0.3 mg/l	----
Pb	50.0 ug/l	----
Mn	50.0 ug/l	100.0 ug/l
Hg	144.0 ng/l	146.0 ug/l
Se	10.0 ug/l	----
Ag	50.0 ug/l	----

2. Current Treatment Standards under permit from East Helena POTW

Contaminant	Average Flow (ppm)	Average Total Load (lbs/day)
As	2.91	0.737
Cd	0.40	0.102
Cu	2.94	0.740
Pb	8.83	2.235
Zn	4.80	1.220

B. <u>Action Specific ARARs</u>

Federal

1. Occupational Safety and Health Act., 29 U.S.C. §§ 651-655, 670

   a. 29 C.F.R. § 1926

   b. 40 C.F.R. § 300.39

2. Clean Water Act, 33 U.S.A. §§ 1251-1376, 1344

   a. 40 C.F.R. Part 230

State

1. Montana Water Quality Act, M.C.A. § 75-5-303

   a. Montana Water Pollution Control Regulations, A.R.M. §§ 16.20.702 and 703

   b. Montana Pollutant Discharge Elimination System Rules, A.R.M. § 16.20.907

2. Montana Safety Act, M.C.A. § 50-71-101 <u>et seq.</u>

3. Montana Streambed Preservation Act., M.C.A. § 75-7-101 <u>et seq.</u>

C. <u>Location-Specific ARARs</u>

Federal

1. National Historic Preservation Act, 16 U.S.C. § 470

   a. 36 C.F.R. Part 800

   b. 40 C.F.R. § 6.301(b)

2. Archeological and Historic Preservation Act, 16 U.S.C. § 464

   a. 40 C.F.R. § 6.301(c)

3. Historic Sites, Buildings and Antiquities Act 16 U.S.C. §§ 461-467

   a. 40 C.F.R. § 6.301(a)

4. Endangered Species Act 16 U.S.C. § 15.31

    a. 50 C.F.R. Part 402

    b. 50 C.F.R. Part 17

5. Fish and Wildlife Coordination Act, 16 U.S.C. § 661 et seq.

    a. 40 C.F.R. § 6.302(g)

6. Appendix A, Executive Order on Floodplain Management, Executive Order No. 11,988

    a. 40 C.F.R. § 6.302(b)

State

1. Montana State Parks and Antiquities Laws, M.C.A. § 23-1-101 et seq. and 22-3-421 through 22-3-435

    a. Cultural Resources Regulations, 12, A.R.M. § 12.8.501 et seq.

2. Nongame and Endangered Species Conservation Act, M.C.A. § 7-5-101 et seq.

    a. Endangered Species List, Title 12, A.R.M. § 12.5.201

3. Streambed Preservation Act, M.C.A. § 75-7-101 et seq.

4. Montana Floodplain and Floodway Management Act, M.C.A. § 76-5-101 et seq.

    a. Floodplain and Floodway Management Regulations, A.R.M. § 36.15.101 et seq.

GROUNDWATER ARARs

Chemical-Specific ARARs

Federal

National Primary Drinking Water Standards, 40 C.F.R. Part 141

Contaminant	MCL (mg/l)
Arsenic	0.05
Cadmium	0.01
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05

1. Pretreatment Standards, 40 C.F.R. Part 403

State

1. Montana Ground Water Act, M.C.A. § 85-2-505

   Waste and contamination of ground water is prohibited.

2. Ground Water Pollution Control Regulations

   a. A.R.M. § 16.20.1002

   Ground water classifications to protect present and future most beneficial uses.

   b. A.R.M. § 16.20.1003
   Ground Water Standards

Chemical	Level (mg/l)
As	0.05
Cd	0.01
Pb	0.05
Hg	0.002
Se	0.01
Ag	0.05

   c. A.R.M. § 16.20.1011
   Nondegradation requirement

Action-Specific ARARs

Federal

1. OSHA, 29 U.S.C. § 651-655, 670

   a. 29 C.F.R. § 1926

   b. 40 C.F.R. § 300.39

2. Safe Drinking Water Act, 42 U.S.C. § 300(f) et seq.
   Clean Water Act, 33 U.S.C. §§ 1251-1326, 1342

   a. 40 C.F.R. Part 131

   b. 40 C.F.R. Part 141

   c. 40 C.F.R. Part 143

   d. EPA "Gold Book" Values

   e. 40 C.F.R. Part 125

State

1. Montana Safety Act, M.C.A. § 50-71-101 et seq.

   a. A.R.M. § 16.42.101, 102

   The following levels have been established by the State:

Contaminant	ppm	mg/m^3
As	---	0.5
Cu (dust/mists)	---	1.0
Cu (fume)	---	0.1
Pb	---	0.15
Se	---	0.2
Tl	---	0.2

2. Montana Water Quality Act, M.C.A. § 75-5-101

   a. A.R.M. § 16.20.901 et seq. (relates to treat and discharge to Prickly Peak Creek alternative)

   b. A.R.M. § 16.20.631

Location-Specific ARARs

Federal and State

Aside from the location-specific requirements which are applicable or relevant and appropriate to remedial activities for all media, there are no additional location-specific ARARs for ground water.

SOILS/SEDIMENTS ARARs

Chemical-Specific ARARs

Federal

1. Clean Air Act, 42 U.S.C. §§ 7401-7642

    a. 40 C.F.R. Part 50

National Primary and Secondary Ambient Air Quality Standards

Parameter	Standard
Particulate: 24 hour average concentration	150 ug/m^3
Particulates: Annual arithmetic mean	50 ug/m^3
Lead (averaged over a calendar quarter)	1.5 ug/m^3

NB: Particulate matter is measured as PM-10 (aerodynamic diameter equal to or less than 10 um)

State

1. Montana Clean Air Act, M.C.A. § 75-2-102

    a. Montana Clean Air Regulations, A.R.M. §§ 16.8.815, .821, .1401(4)

    b. A.R.M. § 16.8.1427

Action-Specific ARARs

Federal

1. OSHA, 29 U.S.C. §§ 651-678:

    a. 29 C.F.R. § 1929

    b. 40 C.F.R. § 300.38

2. Clean Air Act, 42 U.S.C. §§ 7401-7642

    a. 40 C.F.R. Part 50

3. Clean Water Act, 33 U.S.C. §§ 1251-1376
   Safe Drinking Water Act, 42 U.S.C. § 300(f) _et seq._

    a. 40 C.F.R. Parts 141 and 143

4. Resource Conservation and Recovery Act, 42 U.S.C. § 6901 _et seq._

   a. 40 C.F.R. Parts 260-262, 268

State

1. Montana Safety Act, M.C.A. § 50-71-201 _et seq._

2. Montana Hazardous Waste Management Act, M.C.A. §§ 75-10-403, 405 and 406

   a. Hazardous Waste Regulations, Title 16, A.R.M. §§ 16.44.101, .102, .103, .202, .302, .303 and .401 _et seq._

3. Montana Solid Waste Management Act, M.C.A. § 75-10-201 _et seq._

   a. Regulations, A.R.M. § 16.14.501 _et seq._

SLAG PILE ARARs

All applicable or relevant and appropriate requirements for the Slag Pile remediation alternatives are identical to those outlined in the Surface Water remediation alternatives analysis.

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APPENDIX 10-1

**EXPOSURE ASSESSMENT INTAKE EQUATIONS,
ASSUMPTIONS, AND INTAKE TABLES**

10-1.1 CONTAMINANT INTAKE MODELS

10-1.1.1 VEGETATION

Vegetation may be adversely affected by contaminants that are located within the root zone of the ground. These contaminants may harm the root system or may be taken up by the roots and translocated to another part of the plant where an adverse effect manifests itself. The means by which a contaminant reaches the soil surrounding a vegetative receptor are varied and include irrigation and airborne deposition. Once in the soil, the concentration of the contaminant then becomes the critical factor, and future effects are dependent on the soil concentration.

Thus, it is not necessary to determine the actual uptake of a plant to estimate the toxic effects to vegetation. Values are available in the literature (EPA, 1987a) that are considered to be tolerable soil concentrations. To determine the potential risk of harm to the vegetation, current soil concentrations may be compared to these tolerable concentrations.

10-1.1.2 AQUATIC ORGANISMS

As with vegetation, it is not necessary to estimate uptake by aquatic organisms. The method of estimating risk to aquatic organisms is to compare known or estimated water concentrations with Ambient Water Quality Criteria (AWQC) values or, if unavailable, to values published in the literature that estimate toxicological endpoints, such as LC50 values, that have been adjusted using appropriate uncertainty factors.

As presented in the risk characterization section, current water quality data, represented by maximum and mean values, will be compared to the AWQCs or other representative toxicity values.

10-1.1.3 LIVESTOCK

There are four pathways by which livestock may be exposed to contaminants from the East Helena site: ingestion of surface water, soil, and feeds and forage and inhalation of airborne contaminants. Because most livestock animals are not expected to have a lifespan sufficiently long to develop cancer, as they are processed at an early age, no acceptable risk range has been determined; rather, the emphasis is on the noncarcinogenic effects of the carcinogenic elements. For the noncarcinogenic elements, the primary concerns are the threshold effects.

1. Ingestion of surface water:

$$D_{t-L} = (C_{sw})\ (WC_L)/BW_L$$

where: D_{t-L} = average daily intake of cattle (mg/kg/day),
C_{sw} = concentration in surface water (mg/L),
WC_L = average water consumption rate of cattle (L/day), and
BW_L = body weight of livestock (kg).

2. Ingestion of soil:

$$D_{t-L} = (C_s)\ (SC_L)/BW_L$$

where: D_{t-L} = average daily intake of cattle (mg/kg/day),
C_s = concentration in soil (mg/kg),
SC_L = average soil ingestion rate of cattle (kg/day), and
BW_L = bodyweight of livestock (kg).

3. Ingestion of feeds and forage:

$$D_{t-L} = (C_{for})(ForC)/BW_L$$

where: D_{t-L} = average daily intake of cattle (mg/kg/day),
C_{for} = concentration in feed/forage,
ForC = average daily consumption rate of feed/forage (kg/day), and
BWL = body weight of livestock (kg).

4. Inhalation of outdoor air:

$$D_{t-L} = (C_{air})\ (IR_L)\ (RF)/BW_L$$

where: C_{air} = concentration in air (mg/m^3),
IR_L = average inhalation rate for cattle (m^3/day),
RF = respirable fraction (unitless), and
BW_L = bodyweight of livestock (kg).

10-1.1.4 **HUMAN**

There are a number of mechanisms by which contaminants may reach a human receptor; in some instances, the contaminants are passed upward through several trophic levels; i.e., soil to water to soil to plant to livestock to human. Nine pathways were selected as representing the pathways of concern for the representation of human exposure. The equations used to estimate the rate of exposure are presented as follows:

1. Ingestion of soil:

$$D_t = (C_s)\ (SC_h)\ (GA_h)/BW_h \qquad \text{(A-1)}$$

where: D_t = average daily intake (mg/kg/day),
C_s = soil concentration (mg/kg),
SC_h = average human soil ingestion rate (kg/day),
GA_h = gut absorption (unitless), and
BW_h = average human body weight (kg).

2. Ingestion of sediments:

$$D_t = (C_{sed})\ (SedC_h)\ (GA_h)/BW_h \qquad \text{(A-2)}$$

where: D_t = average daily intake (mg/kg/day),
C_{sed} = sediment concentration (mg/kg),
$SedC_h$ = average human sediment ingestion rate (kg/day),
GA_h = gut absorption (unitless), and
BW_h = average human body weight (kg).

3. Ingestion of leafy vegetables:

$$D_t = (C_{veg})\ (SVC)\ (GA_h)/BW_h \qquad \text{(A-3)}$$

where: D_t = average daily intake (mg/kg/day),
C_{veg} = vegetable concentration (mg/kg),
SVC = average human leafy vegetable ingestion rate (kg/day),
GA_h = gut absorption (unitless), and
BW_h = average human body weight (kg).

4. Ingestion of root vegetables:

$$D_t = (C_{root})\ (RVC)\ (GA_h)/BW_h \qquad \text{(A-4)}$$

where: D_t = average daily intake (mg/kg/day),
C_{root} = root vegetable concentration (mg/kg),
RVC = average human root vegetable ingestion rate (kg/day),
GA_h = gut absorption (unitless), and
BW_h = average human body weight (kg).

5. Ingestion of meat:

$$D_t = (C_{meat})\ (MC)\ (GA_h)/BW_h \qquad \text{(A-5)}$$

where: D_t = average daily intake (mg/kg/day),
C_{meat} = concentration in meat (mg/kg),
MC = average human meat consumption rate (kg/day),
GA_h = gut absorption (unitless), and
BW_h = average human body weight (kg).

6. Dermal absorption--water:

$$D_t = (C_{sw})\ (D)\ (Freq)\ (A_h)\ (Flux)\ (AF)\ (1 \times 10^{-6})/BW_h \qquad \text{(A-6)}$$

where: D_t = average daily intake (mg/kg/day),
C_{sw} = surface water concentration (mg/L),
D = duration of event (hr/event),
Freq = average number of daily events (events/day),
A_h = area of exposure (cm^2),
Flux = rate of movement of mass of solute across unit area per unit time ($mg/cm^2/hr$),
AF = fraction of contaminant in solute absorbed (unitless),
1×10^{-6} = factor to adjust water unit from mg to L, and
BW_h = average human body weight (kg).

7. Dermal absorption--soil:

$$D_t = (Freq)\ (A_h)\ (DA)\ (C_{s\text{-}f})(AF)/BW_h \qquad \text{(A-7)}$$

where: D_t = average daily intake (mg/kg/day),
Freq = average daily exposure frequency (event/day),
A_h = area of exposure (cm^2/event),
DA = dust adherence (mg/cm^2),
$C_{s\text{-}f}$ = concentration in soil expressed as a fraction (mg/mg),
AF = absorption fraction (unitless), and
BW_h = average human body weight (kg).

8. Dermal absorption--sediments:

$$D_t = (Freq)\ (A_h)\ (DA)\ (C_{sed\text{-}f})(AF)/BW_h \qquad \text{(A-8)}$$

where: D_t = average daily intake (mg/kg/day),
$Freq$ = average daily exposure frequency (event/day),
A_h = area of exposure (cm^2/event),
DA = dust adherence (mg/cm^2),
$C_{sed\text{-}f}$ = concentration in soil expressed as a fraction (mg/mg),
AF = absorption fraction (unitless), and
BW_h = average human body weight (kg).

9. Ingestion of Irrespirable Particles

$$D_t = [(C_{air})(IR_h)(IRF)/BW_h] + [(C_s)(IR_h')(IRF')/BW_h] \qquad \text{(A-9)}$$

where: D_t = average daily intake (mg/kg/day),
C_{air} = concentration in air (mg/m^3),
IR_h = human inhalation rate (m^3/day),
IRF = irrespirable fraction (unitless),
GA_h = gut absorption (unitless),
BW_h = average human body weight (kg),
C_s = concentration in soil (mg/kg),
IR_h' = human inhalation rate (kg/day), and
IRF' = 1-lung absorption rate

10. Inhalation of Outdoor Air:

$$D_t = (C_{air})\ (IR_h)\ (RF)\ (LA)/BW_h \qquad \text{(A-10)}$$

where: D_t = average daily intake (mg/kg/day),
C_{air} = concentration in air (mg/m^3),
IR_h = human inhalation rate (m^3/day),
RF = respirable fraction (unitless),

LA = lung absorption (unitless), and
BW_h = average human body weight (kg).

11. Inhalation of Indoor Air:

$$D_t = (C_s)\ (IR_h')\ (LA)/BW_h \qquad \text{(A-11)}$$

where: D_t = average daily intake (mg/kg/day),
C_s = soil concentration (mg/kg),
IR_h' = human inhalation rate (kg/day),
LA = lung absorption (unitless), and
BW_h = average human body weight (kg).

For the maximum exposure scenario, the following two equations are added to the previous equations:

1. Ingestion of groundwater:

$$D_t = (C_{gw})\ (WC_h)/BW_h \qquad \text{(A-12)}$$

where: D_t = average daily intake (mg/kg/day),
C_{gw} = groundwater concentration (mg/L),
WC_h = average human water consumption rate (L/day), and
BW_h = average human body weight (kg).

2. Ingestion of grain:

$$D_t = (C_{grain})(GC)\ (GA_h)/BW_h \qquad \text{(A-13)}$$

where: D_t = average daily intake (mg/kg/day),
C_{grain} = concentration in grain (mg/kg),
GC = average human grain ingestion rate (kg/day),
GA_h = gut absorption (unitless), and
BW_h = average human body weight (kg).

These equations allow for the estimation of the daily intake by either the average child, youth, or adult. While the intakes are calculated separately for the different media--soil, sediments, surface water, air, and groundwater (under maximum exposure scenarios)--to which individuals may be exposed, those routes of exposure leading to the same toxicological effects may be summed. Thus, dermal absorption and oral ingestion may be summed as the toxicological endpoint and is the same for either route; the intake equation quantifies the difference in the total quantity that actually reaches the point of effect. Inhalation represents a different route because the affected organ and the mechanism of action are often different from those associated with the other routes of exposure. Once calculated, these intake values may be compared with the intake values associated with specific endpoints to determine the carcinogenic and noncarcinogenic risks.

10-1.2 ASSUMPTIONS

Inherent in the exposure assessment are assumptions regarding many of the factors that are part of the equations used to estimate intake values. Assumptions may be general, such as dealing with an approach to be used in estimating an exposure, or specific, as when dealing with specific values to be assigned to individual parameters.

10-1.2.1 **GENERAL ASSUMPTIONS**

10-1.2.1.1 Aquatic Organisms

1. Concentrations in Prickly Pear Creek will vary greatly as the quantity of water in the creek varies as a result of storm events or other uncontrollable outside events. However, for the purpose of the exposure assessment, these concentrations are assumed to be steady throughout the year. Similarly, sediment concentrations are expected to remain constant.

10-1.2.1.2 Vegetation

1. Because dryland farming is practiced, few if any of the grain fields are irrigated. The fields reported to be irrigated are primarily used to grow either forage or hay. Groundwater is reported to be the main source of irrigation water; minimal use of surface water from the Missouri River Basin (Canyon Ferry Lake) also is reported. As contaminated groundwater is not expected to reach any of the farms, irrigation is not expected to contribute to the contamination of the vegetation.
2. While surface deposition of airborne contaminants onto foliar surfaces is assumed to occur, washing of the edible portions is assumed to lower the amount to which an individual is exposed to an insignificant level.

10-1.2.1.3 Livestock

1. Both the feed and forage and the water supplied to cattle are from the same agricultural water supply, which is assumed to be Prickly Pear Creek.
2. Cattle absorb and bioaccumulate contaminants ingested with feed to the same extent that they absorb and bioaccumulate contaminants ingested with water.
3. Dermal absorption from soil is expected to be minimal because the hair and the thickness of the skin will keep contaminants from entering the body through this pathway without the influence of a solvent such as water.

10-1.2.1.4 Human

1. Absorption was considered based on media and chemical-specific parameters, i.e., absorption rates for various indicator chemicals were applied based on water, soil, and dermal exposure.

2. In the case of inhalation, it is assumed that only a portion of the contaminants associated with the respirable fraction is absorbed across the lung tissue. Irrespirable particles were assumed to be incidentally ingested via mucocilliary action in the trachea.

10-1.2.2 DEFINITION OF SITE-SPECIFIC PARAMETERS

An exposure assessment requires the definition of many parameters for use in the exposure models. Chemical-specific parameters are those values that change with the contaminant being modeled. Site-specific parameters are independent of the contaminant, retaining the same value for each indicator chemical. Site-specific parameters are used in the determination of contaminant intake and are presented below for both human and nonhuman receptor pathways.

10-1.2.2.1 Aquatic Organisms

As the aquatic organisms are being assessed only in terms of current surface water concentrations, the risk is a function of the relationship between the surface water concentration and the AWQC or other acceptable surface water concentration. As such, there are no site-specific parameters to be discussed.

10-1.2.2.2 Vegetation

The toxicity of the contaminants to vegetation is determined by comparing soil concentrations with the soil concentrations determined as tolerable by EPA (1987a). No further discussion of parameters is warranted.

10-1.2.2.3 Livestock

Livestock and human receptors share some common exposure pathways: ingestion of water, ingestion of soil, ingestion of vegetation (although the plant tissues ingested differ), and inhalation. As indicated in the equations presented for these pathways, there are several site-specific parameters that need to be addressed.

Body Weight (BW_L)

Body weight is extremely variable from individual to individual and is dependent on a number of input parameters. Nevertheless, some general values are available that are pertinent. Osweiler et al. (1985) present a range of values for maturing beef cattle, with an upper value of 450 kg. Other reports discuss toxicity and uptake in terms of a 400-kg or 500-kg animal (Fries and Jacobs, 1986; Paustenbach, 1987). The value of 450 kg was selected as the best estimate.

Inhalation Rate (IR_L)

Based on the reported value of Prosser (1973), the average cow inhales 69 m^3 of air per day. A review of the available literature did not find any additional values; therefore, this value is used in the assessment.

Daily Drinking Water Ingestion by Beef Cattle (SC_L)

Osweiler et al. (1985) reported several ranges for water consumption by cattle that are dependent on whether range or feedlot cattle; 38 to 45 L/day (range), 15 to 23 L/day (feeder calves), and 30 to 38 L/day (finishing steers); 38 L/day is the midpoint between the more mature animals and represents the best estimate of water intake.

Soil Ingestion by Beef Cattle (WC_L)

It has been recognized that the incidental ingestion of soil by grazing livestock may represent a major intake pathway of contaminants. A number of studies have been carried out by USDA to evaluate the overall effect of soil ingestion in terms of both animal health and the movement of contaminants through the human food chain (Fries and Jacobs, 1986; Fries, 1987; Fries et al., 1982a; 1982b; Healy, 1968; Paustenbach, 1987). Fries et al. (1982b) summarized the average soil intake by herds on pasture from 4 to 8 percent of dry matter intake when the cows received no other feed. However, soil ingestion is not uniform throughout the year but ranges from as low as 2 percent of dry matter intake during seasons of lush plant growth to as high as 14 percent during seasons of poor plant growth. Healy (1968) reported that the average daily soil intake for a lactating cow ranged from 1.7 to 4.1 g/day, representing periods of lush growth and sparse growth, respectively. For the East Helena area, lush growth was assumed to occur for 4 months, sparse growth for 4 months, and no growth for 4 months; during the latter period, the animals were assumed to be fed hay from local fields but were not expected to graze and, therefore, would not ingest soil. The annualized average daily soil intake is 1.93 g/day.

Daily Forage Consumption by Beef Cattle (ForC)

As with the drinking water consumption, the forage consumption is dependent on several variables. There are several reports regarding the overall dietary requirements of beef cattle that provide generalized data concerning forage consumption. No distinction is made concerning the type of forage being consumed, which may be hay (grass or legume), green chop, silage, or fresh grass. The following table presents the average intake or range as available, with values adjusted to a wet weight basis:

Mean Consumption (kg/day)	Range (kg/day)	Source
30.4	NP	Shor *et al.*, 1982
34.8	NP	Shor *et al.*, 1982
23.6	NP	Baxter *et al.*, 1983
NP	33.4 to 38.4	Wilson *et al.*, 1970
NP	20 to 24	Osweiler *et al.*, 1985

Note: NP - not provided by the referenced authors.

In addition, Church (1977) presented several ranges of forage consumption based on age, condition, lactation status, and whether at pasture or in a feedlot. The following represent the ranges in kg/day presented by Church (1977) for several different studies: 22 to 98, 29 to 33, 22 to 31, 40 to 51, and 48 to 62 kg/day. In general terms, Osweiler et al. (1985) states that the weight of food eaten per day ranges from 2.1 to 2.5 percent of body weight, while Bagley (1985) suggested using a value of 3 percent body weight, which closely compares to the consumption rates found by Church (1977). The latter value will be used as the best estimate, which provides a forage consumption rate of 14 kg/day for a 450-kg animal.

10-1.2.2.4 Human

Body Weight (BW_h)

Although body weight varies within a population and for an individual over time, the adult body weight is assumed to remain constant for this analysis. EPA (1980a; 1985a; 1986a; 1986c) has used 70 kg as the representative adult body weight in the development of water quality criteria, drinking water standards, and risk assessment handbooks. This assessment uses the 70-kg value.

For the younger groups, child and youth, the values used in this assessment are 14 and 39 kg, respectively. These values represent the average body weights for ages 0 to 6 and ages 7 to 12, respectively, and were derived by EPA for use in exposure assessments (EPA, 1985b).

Dermal Area

In addition to the body weights presented above, EPA (1985b) carried out a statistical analysis of several factors, including an analysis of body surface areas for children from 0 to 18 years old at one-year intervals and then for an average adult male and for an average adult female. For this EA, the body surface area representing the 50th percentile for the male age group of 3 to 4 years old was used to represent a child; for the youth, the 50th percentile body surface area of the male age group of 9 to 10 years old were averaged. The average body area for the average adult male was used for the adult exposure. Table A-1 presents the areas for the different parts of the body.

Inhalation Rates (IR_h)

An EPA (1985j; 1987c) study determined the average hourly inhalation for children, youth, and adults. Table A-2 presents the derivation of the daily inhalation volumes based on the number of hours per 24-hour period spent at each activity level.

Drinking Water Ingestion Rate (WC)

EPA (1985a; 1986a; 1988a) uses an ingestion rate of 2 L/day of water to represent the average daily water intake for an adult, 1 L/day for a child. Studies by other investigators have identified different values; Andelman (1984; 1985) derived a tap water consumption rate of 0.15 L/day from information in a study completed by the International Commission for Radiological Protection (ICRP, 1975). This value did not include intake via coffee, tea, and other beverages made using tap water. Referring to information contained in a survey completed by the U.S. Department of Agriculture (USDA, 1983), these latter beverages could account for an additional 0.5 to 0.75 L/day.

These values do not include incidental ingestion during other activities, such as cooking, cleaning, or bathing. Therefore, it is assumed that the 2 L/day recommended by EPA is sufficiently conservative to include all of these exposure scenarios.

Table A-1. Estimated Skin Surface Areas Used in Dermal Exposure Analyses

Age Group	Total Body Surface Area (cm^2)*	Forearms+ Fraction of Total Area	Forearms+ Surface Area (cm^2)	Hands Fraction of Total Area	Hands Surface Area (cm^2)	Lower Legs** Fraction of Total Area	Lower Legs** Surface Area (cm^2)	Feet Fraction of Total Area	Feet Surface Area (cm^2)	Head Fraction of Total Area	Head Surface Area (cm^2)	Total++ Fraction of Total Area	Total++ Surface Area (cm^2)
Child, less than	6,640	0.058	385	0.061	405	0.107	710	0.072	478	0.136	903	0.298	1,978
6 years old	+1/2 upper arm--	0.038	251	+1/2 thigh area--		0.079	525						
Youth, 7 to	10,700	0.049	524	0.053	567	0.115	1,230	0.076	813	0.120	1,293	0.293	3,134
12 years old	+1/2 upper arm--	0.038	403	+1/2 thigh area--		0.079	846						
Adult, 13 to	19,400	0.059	1,145	0.052	1,009	0.128	2,483	0.070	1,358	0.078	1,513	0.239	4,637
70 years old	+1/2 upper arm--	0.037	718	+1/2 thigh area--		0.092	1,785						

*Body surface area and fraction of total area based on median (50th percentile) for children. Areas for children less than 6 years old based on values for 3 to 4 year olds; areas for 7 to 12 year olds based on median for 9- to 10-year olds (EPA, 1984h).

+No values reported by EPA (1984h) for children. Assumed area of forearm is 0.4 of whole-arm surface area, based on extrapolation from adult proportions.

**No values reported for children. Assumed area of lower legs is 0.4 of whole-leg surface area based on extrapolation from adult proportions.

++Soil totals assume feet are exposed only in children and youths. Adults are assumed to wear shoes.

Source: EPA, 1985b.

Table A-2. Derivation of Daily Inhalation Volumes

Subpopulation	Activity Level*	Hourly Inhalation Rate (m^3/hr)+	Hours per Activity	Fraction of 24-Hour Day	Adjusted Inhalation Rate (m^3/hr)	Daily Inhalation Rate (m^3/day)
Child, less than 6 years old	Resting	0.4	12	0.50	0.20	4.80
	Light	1.4	10.5	0.44	0.62	14.88
	Moderate	2.1	1	0.04	0.08	1.92
	Heavy	2.4	0.5	0.02	0.05	1.20
Total			24		**0.95**	**22.80**
Youth, 7 to 12 years old	Resting	0.4	12	0.5	0.20	4.80
	Light	1.7	10	0.42	0.71	17.04
	Moderate	3.3	1	0.04	0.13	3.12
	Heavy	4.2	1	0.04	0.17	4.08
Total			24		**1.21**	**29.04**
Adult at home**	Resting	0.6	12	0.50	0.30	7.20
	Light	1.3	10.4	0.43	0.56	13.44
	Moderate	2.6	1.3	0.06	0.16	3.84
	Heavy	6.0	0.3	0.01	0.06	1.44
Total			24		**1.08**	**25.92**

Note: Adjusted inhalation rate (m^3/hr) = Hourly inhalation rate (m^3/hr) x fraction of day.
Daily inhalation rate (m^3/hr) = Adjusted inhalataion rate (m^3/hr) x 24 hrs/day.
m^3/hr = cubic meters per hour.

*EPA, 1987c. Resting includes sleeping, watching television, and reading. Light activity includes domestic work, hobbies, minor indoor repairs, and home improvements. Moderate activity includes heavy indoor cleaning, major indoor repairs, and climbing stairs. Heavy activity includes vigorous physical exercise and climbing stairs with a load.
+EPA, 1987c.
**Assumes person spends days at home and does not work outside the home.

Soil and Sediment Consumption Rates (SC_h and SedC)
Because no studies are available that evaluated the intake of sediments by an individual, sediment consumption rates are assumed to be a component of the soil ingestion rates used for this EA. When receptors are exposed to both media, the total intake will be apportioned between the two media based on the ratio of their respective exposure times.

Based on reports by Hawley (1985) and LaGoy (1987) that summarized data from several studies, the reported average values range for the most part between 25 to 200 mg of soil ingested per day (mg/day) with a higher bound estimate of 100 to 500 mg/day. Defining pica as the abnormal ingestion of soil and other objects, children with habitual pica may ingest up to 500 to 1,000 mg/day. These values are in agreement with the soil ingestion values of 50 to 60 mg/day for children estimated as part of human biokinetic uptake models employed at East Helena, MT; Kellogg, ID; Herculaneum, MO; and Toronto, Canada to determine a relationship between soil lead and blood lead in children living near lead smelters (Hoffnagle, 1988). In these studies, it was determined that a nearly 1:1 correlation between soil lead and blood lead was shown when ingestion rates of between 50 mg/day and 60 mg/day were employed. These data are a better basis on which to derive soil ingestion rates because they specifically involve soil lead and blood lead data compiled around lead smelters in North America. Such data represent a database more appropriate than the EPA Directive 9850.4 for employing more site-specific soil ingestion rates. As such, ingestion rates for soil will be as follows: 57 mg/day for children and 50 mg/day for youth and adults.

Root Vegetable Consumption Rate (RVC) and Shoot Vegetable Consumption Rate (SVC)
Data for estimating the quantity of vegetables consumed by East Helena residents were taken from a survey completed in conjunction with the RI

and from the results of USDA food consumption surveys (USDA, 1982; USDA, 1983), which reported intake values divided into geographic region, demographic setting (urban, suburban, rural), and income level. The vegetable portion of a typical adult diet for a United States household is presented in Table A-3 for both the 50th percentile and the 95th percentile of the adult population; these values are used to estimate the representative and worst-case intakes, respectively. Based on the USDA (1982; 1983) statistics, the total daily adult vegetable intake is 257 grams per day (g/day). Applying the results of the East Helena Vegetable Garden Survey (MDI, 1988), 7.66 percent of the yearly vegetable supply is associated with the 50th percentile of the population sampled. This indicates that half of the people surveyed get 7.66 percent of their vegetables from their home gardens. The survey data indicate 56.8 percent of the total yearly vegetable supply is associated with the 95th percentile of the population. Daily total fresh vegetable intake estimates for the 50th and 95th percentiles are included in Table A-3. Table A-4 presents the 50th and 95th percentile values for a child aged 3 to 5 years. These values are based on the food intake studies conducted by USDA (1982; 1983), assuming that 100 percent of a child's vegetable intake comes from a home vegetable garden, if available.

Grain Consumption (GC)

A survey of grain consumption was completed for the East Helena area as part of the RI. The results of the survey show that only two families were identified as consumers of locally grown grain. Because such a small number of consumers were identified, grain consumption will not be included in the representative exposure scenario, but will be included in the worst-case scenario. For the latter exposure, the consumption rate was developed from the USDA surveys (1982; 1983). The mean value reported for this region is 135 g/day with a range of 100 to 149 g/day. The survey reported that the families ground approximately 500 to 600

Table A-3. Derivation of Adult Daily Consumption of Home-Produced Fresh Vegetables (wet weight)

		Consumption (g/day)	
Vegetable Crop	Total (g/day*)	Home Produced 50th Percentile	Home Produced 95th Percentile
Green Leafy Vegetables			
Lettuce	31.9	2.44	18.1
Swiss Chard	3.11	0.238	1.77
Beet Greens	3.11	0.238	1.77
Parsley	1.81	0.139	1.03
Other	17.8	1.36	10.1
Roots			
Potatoes	80.6	6.17	45.8
Carrots	9.84	.754	5.59
Other	16.8	1.29	9.54
Fruits			
Tomatoes	23.0	1.76	13.1
Other Vegetables			
All	69.0	5.29	39.2
Total	257	19.7	146

Note: Based on results of the East Helena Vegetable Garden Survey (MDI, 1988), 7.66 percent of the yearly vegetable supply is associated with the 50th percentile of the population sampled, while 56.8 percent of the yearly vegetable supply is associated with the 95th percentile.

g/day = grams per day

*All data from USDA, 1982.

Table A-4. Daily Consumption of Home-Produced Fresh Vegetables by Children 3 to 5 Years Old (wet weight)

Vegetable Crop	Total (g/day)	Consumption (g/day) Home Produced 50th Percentile	Consumption (g/day) Home Produced 95th Percentile
Potatoes	32	2.45	18.2
Tomatoes	15	1.15	8.52
Green Leafy Vegetables	2	0.153	1.14
Carrots	4	0.306	2.27
Other Vegetables	45	3.45	25.6
Total	98	7.52	55.7

Note: g/day - grams per day

Source: USDA, 1983.

pounds of grain a year, which represented about 75 percent of their annual baked goods intake. Based on a family of four, this is approximately equal to 140 g/day, equivalent to the USDA value.

Meat Consumption (MC)

As with vegetable and grain consumption, the meat consumption rate is derived from data provided in the USDA survey results (1982; 1983). To estimate a conservative consumption rate, the sum of the consumption data for all meat for all demographic settings for the western United States was selected as representative of the East Helena population. The mean across all economic groups, 179 g/day, was selected as the best estimate, with a range of 116 to 225 g/day. Because the USDA value is based on a large database, it will be used in the risk characterization.

Gut Absorption (GA_h)

Only a portion of a chemical that is ingested is absorbed into the bloodstream. The percentage varies depending upon the contents of the gut and the nutritional status of the human receptor. For the indicator chemicals selected for the comprehensive EA, a range of absorption rates between 0 and 100 percent has been defined for human receptors. These rates have been taken from the Health Effects Assessment documents published by EPA for each metal (EPA, 1984a; 1984b, 1984c; 1984e; 1984f; 1984g; 1984h) and from the biokinetic model employed by the Office of Air Quality Planning and Standards of EPA (1986f). The absorption rates to be used are as follows: arsenic--70 percent; cadmium--1.5 percent, copper--60 percent, lead--10 percent, zinc--37.5 percent, iron--17.5 percent, and manganese--4 percent.

Dust Adherence (DA)

This term used by EPA (1988b) to describe the ability of a soil to adhere to the body is expressed in units of milligram per square centimeter (mg/cm^2). While data on dust adherence to skin are limited, the Toxic Substance Control Commission of the State of Michigan (Harger, 1979) reported that commercial potting soil adheres to hands at 1.45 mg/cm^2 while dust of the clay mineral kaolin adheres to hands at 2.77 mg/cm^2.

Ground soil is assumed to be less adherent than potting soil; therefore, a value of 1.0 mg/cm^2 was assigned to ground soil. The adhesion of sediment is expected to fall between the two soil types and was therefore set at 1.23 mg/cm^2, the midpoint value.

Flux

This term describes the movement of a material across the dermal barrier and is described in terms of milligrams of compound per square centimeter of skin surface per hour of exposure (mg/cm^2/hr). At one time, EPA (1988c) provided a flux range of 0.1 to 0.5 mg/cm^2/hr, recommending that the value of 0.5 mg/cm^2/hr be used in determining the exposure.

Absorption Fraction (AF)

This value is used to adjust the exposure rate to represent the amount of contaminant entering the body. Ryan et al. (1987) state that the most conservative approach is to assume 100 percent absorption but that the limited data available indicate that dermal absorption of contaminants in a liquid phase occurs at rates less than 100 percent. The authors indicate that the scientific literature shows that between 1 and 5 percent of inorganic compounds can be dermally absorbed when exposure occurs in the liquid phase. They conclude that the absorption factors of inorganic compounds from soil range from 0.1 to 1 percent. The values of 1 percent and 0.1 percent will be used for dermal exposure of metals from water and soil, respectively.

Respirable Fraction (RF)

This value represents the percentage of the inhaled dust that is expected to reach the lungs. For the risk characterization, this value was calculated based on a ratio of the data from the high-volume air samples and the PM10 air samples. A comparison of the analytical data indicates that 51 percent of the contaminants were found associated with the inhalable fraction (particles less than 10 micrometers). This value, therefore, represents the respirable fraction, RF. The fraction that is not respirable follows the ingestion pathway after mucociliary movement to the esophagus and being swallowed.

Lung Absorption (LA)

Only a portion of an inhaled chemical is deposited in the lung and subsequently absorbed into the bloodstream. The deposition efficiency of the chemical depends primarily on the size of the particle to which it is adhered and the physiology and rate of breathing of the individual. Respiratory deposition/absorption rates have been selected for the indicator chemicals that span a range of 45 to 75 percent for a human receptor. These deposition/absorption rates have been defined based on values described in the Health Effects Assessment documents published by EPA (1984a, 1984b, 1984c, 1984e, 1984f, 1984g, 1984h) and the biokinetic model employed by the Office of Air Quality Planning and Standards of EPA (1986f). The absorption rates to be used are as follows: arsenic--30 percent, cadmium--50 percent, copper--50 percent, lead--45 percent, zinc--50 percent, iron--50 percent, and manganese--45 percent.

Time per Event (t_e) and Frequency (freq)

As part of the scope of work to be completed for the study area, a preliminary risk characterization was completed to assess the potential for risk to individuals exposed to Wilson Ditch. It was determined that the primary group at risk was children. As part of the assessment, exposure times were estimated, with play activity time considered to be the exposure time of consequence.

Exposure times for children and youths playing in Wilson Ditch are presented in Table A-5. The hours per event and events per week are best estimates based on the weather conditions; it is recognized that this is only part of the total daily play time. As it was assumed that a child living in Manlove would only be exposed to surface waters and sediments from Wilson Ditch, a separate exposure pattern was used for youths playing in Prickly Pear Creek, which is presented in Table A-6. Children are assumed to be unwilling to play in the creek because of its rocky nature and cold temperature.

The determination of exposure to contaminants in surface water is dependent on both the frequency of exposure and the duration of exposure as the exposure ceases once the receptor is removed from the surface water.

The significance of frequency and duration is different for exposure to soils and sediments. This exposure is based on the assumption that the total daily exposure rate of 100 or 200 mg/day does not change, but that the exposure value must be divided between soil and sediment when the scenario includes both sources. The allocation of exposure is based on the ratio of the time spent at each source; thus, if 12.5 percent of the daily play period (assumed to be 12 hours x 0.125 = 1.5 hours) is spent at the ditch, then 12.5 percent of the daily soil/sediment exposure is considered to be to sediments from the Wilson Ditch. For a youth who ingests 100 mg/day of soil/sediment, the sediment portion would be 12.5 mg/day with the remaining 87.5 mg/day left as incidental soil ingestion. Using this approach, the intakes for soil and sediment are presented in Table A-7.

Table A-5. Summary of Child and Youth Activity and Condition of Wilson Ditch During a Typical Year

Time Period	Days	Days/ Week	Hours/ Day	Condition	Hours of Exposure for Period
March 15 - April 15	30	4	0.5	Dry	9
April 16 - May 31	46	4	0.5	Wet	13
June 1 - August 31	92	6	1.5	Wet	118.5
September 1 - September 30	30	4	0.5	Wet	8.5
October 1 - October 31	31	4	0.5	Dry	9
November 1 - March 15	136	1	0.25	Dry (frozen)	4.75

Table A-6. Survey of Youth Activity in Prickly Pear Creek During a Typical Year

Time Period	Days	Days/Week	Hours/Day	Hours of Exposure for Period
June 1 - June 30	30	4	0.5	8.6
July 1 - August 31	62	6	0.5	26.6
September 1 - September 30	30	2	0.5	4.2
October 1 - May 31	243	0	0	0

Note: Child does not play in Prickly Pear Creek due to the cold temperature of the water and the rocky nature of the creek bottom.

Table A-7. Average Daily Intakes for Soil and Sediment

	Average Daily Intake (mg/day)			
	Wilson Ditch		Prickly Pear Creek	
Group	Soil	Sediment	Soil	Sediment
Child	192	8	200	0.0
Youth	96.0	4.0	99.2	0.8
Adult	100	0.0	100	0.0

10-1.3 DAILY INTAKES FOR EAST HELENA RECEPTORS

Tables A-8 and A-9 present the average concentration data used to calculate daily intakes for East Helena site receptors. Tables A-10 through A-21 present both the environmental concentration data and the chronic daily intake calculations for Child 1, Child 2, Youth 1, Youth 2, Adult, and Composite Lifetime using either representative or maximum observed media concentrations.

Table A-8. Representative Concentration Data for Indicator Chemicals Used in the Exposure Assessment Analysis

Chemical	Concentration in Groundwater (mg/L)	Concentration in SW-PPC (mg/L)	Concentration in SW-WD (mg/L)	Concentration in Soil (mg/kg)	Concentration in Sed-PPC (mg/kg)	Concentration in Sed-WD (mg/kg)	Concentration in Shoot Vegetables (mg/kg)	Concentration in Root Vegetables (mg/kg)	Concentration in Grain (mg/kg)	Concentration in Meat (mg/kg)	Concentration in Air (mg/m^3)
Arsenic	2.94×10^{-1}	1.60×10^{-2}	1.20×10^{-2}	5.71×10^{1}	3.14×10^{1}	8.32×10^{2}	1.11	2.60×10^{-1}	2.20×10^{-1}	5.25×10^{-2}	3.19×10^{-4}
Cadmium	1.70×10^{-3}	5.00×10^{-3}	1.60×10^{-3}	2.48×10^{1}	6.61	1.67×10^{2}	3.30	3.90×10^{-1}	4.50×10^{-1}	5.75×10^{-2}	2.69×10^{-4}
Copper	6.00×10^{-3}	7.00×10^{-3}	8.00×10^{-3}	3.47×10^{2}	8.98×10^{1}	5.71×10^{2}	7.07	3.14	4.74	NA	4.97×10^{-3}
Iron	2.00×10^{-2}	6.70×10^{-2}	7.60×10^{-2}	NA	2.49×10^{4}	2.08×10^{4}	NA	NA	NA	NA	1.44×10^{-4}
Lead	5.00×10^{-3}	6.00×10^{-3}	7.80×10^{-3}	1.12×10^{3}	3.86×10^{2}	4.28×10^{3}	6.42	8.70×10^{-1}	4.90×10^{-1}	1.49×10^{-1}	3.21×10^{-3}
Manganese	1.18	7.20×10^{-2}	1.37×10^{-1}	5.33×10^{2}	1.46×10^{3}	2.36×10^{3}	4.65×10^{1}	3.56	NA	NA	5.30×10^{-5}
Zinc	1.70×10^{-2}	3.60×10^{-2}	2.90×10^{-2}	5.96×10^{2}	8.96×10^{2}	3.00×10^{3}	5.11×10^{1}	9.90	3.68×10^{1}	5.81×10^{1}	1.23×10^{-3}

Note: NA = not analyzed.
Shoot vegetables include leafy green vegetables and tomatoes.
Root vegetables include carrots and potatoes.

Table A-9. Maximum Concentration Data for Indicator Chemicals Used in the Exposure Assessment Analysis

Chemical	Concentration in Groundwater (mg/L)	Concentration in SW-PPC (mg/L)	Concentration in SW-WD (mg/L)	Concentration in Soil (mg/kg)	Concentration in Sed-PPC (mg/kg)	Concentration in Sed-WD (mg/kg)	Concentration in Shoot Vegetables (mg/kg)	Concentration in Root Vegetables (mg/kg)	Concentration in Grain (mg/kg)	Concentration in Meat (mg/kg)	Concentration in Air (mg/m^3)
Arsenic	1.63	7.90×10^{-2}	3.00×10^{-2}	2.18×10^{2}	8.40×10^{1}	2.08×10^{3}	1.99	7.00×10^{-1}	6.10×10^{-1}	7.00×10^{-2}	9.90×10^{-4}
Cadmium	1.40×10^{-2}	1.10×10^{-2}	6.00×10^{-3}	1.12×10^{2}	1.90×10^{1}	2.51×10^{2}	6.82	1.04	2.10	2.00×10^{-1}	2.68×10^{-3}
Copper	1.80×10^{-2}	9.00×10^{-3}	2.00×10^{-2}	6.20×10^{3}	1.95×10^{2}	8.50×10^{2}	9.15	6.70	7.00	NA	8.64×10^{-3}
Iron	6.20×10^{-1}	1.30×10^{-1}	1.25×10^{-1}	NA	3.50×10^{4}	2.36×10^{4}	NA	NA	NA	NA	4.69×10^{-3}
Lead	2.60×10^{-2}	2.00×10^{-1}	2.50×10^{-2}	7.23×10^{3}	1.45×10^{3}	6.53×10^{3}	1.80×10^{1}	2.94	2.20	7.80×10^{-1}	4.59×10^{-3}
Manganese	4.30×10^{1}	2.79×10^{-1}	1.79×10^{-1}	1.18×10^{3}	2.85×10^{3}	2.75×10^{3}	6.45×10^{1}	1.24×10^{1}	NA	NA	1.80×10^{-4}
Zinc	2.50×10^{-1}	8.20×10^{-2}	1.04×10^{-1}	5.20×10^{3}	2.65×10^{3}	4.87×10^{3}	9.33×10^{1}	2.95×10^{1}	6.20×10^{1}	9.44×10^{1}	1.88×10^{-3}

Note: NA - not analyzed.
Shoot vegetables include leafy green vegetables and tomatoes.
Root vegetables include carrots and potatoes.

Table A-10. Representative Chronic Daily Intake (CDI) Calculation for an East Helena Child

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	NA	1.63E-04	NA	2.21E-03	NA	NA	1.07E-05	8.99E-06	2.39E-03	2.40E-06
Cadmium	NA	1.51E-06	NA	1.33E-04	NA	NA	4.66E-06	1.50E-07	1.39E-04	3.48E-06
Copper	NA	8.48E-04	NA	1.34E-02	NA	NA	6.52E-05	9.76E-05	1.44E-02	5.63E-05
Iron	NA	NA	NA	NA	NA	NA	NA	8.53E-06	8.53E-06	1.65E-05
Lead	NA	4.56E-04	NA	1.74E-03	NA	NA	2.11E-04	1.16E-05	2.42E-03	3.76E-05
Manganese	NA	8.68E-05	NA	4.86E-03	NA	NA	1.00E-04	1.97E-07	5.05E-03	3.07E-06
Zinc	NA	9.10E-04	NA	5.35E-02	NA	NA	1.12E-04	1.78E-05	5.45E-02	1.82E-05

Note:

NA = Not Analyzed.

BKD = At Background Levels

Child is assumed to live in East Helena

Table A-11. Representative Chronic Daily Intake (CDI) Calculation for a Manlove Child

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	NA	1.60E-04	4.58E-05	2.21E-03	NA	NA	9.33E-05	8.99E-06	2.52E-03	2.40E-06
Cadmium	NA	1.49E-06	1.97E-07	1.33E-04	NA	NA	2.13E-05	1.50E-07	1.56E-04	3.48E-06
Copper	NA	8.32E-04	2.69E-05	1.34E-02	NA	NA	1.22E-04	9.76E-05	1.45E-02	5.63E-05
Iron	NA	NA	2.86E-04	NA	NA	NA	2.07E-03	8.53E-06	2.36E-03	1.65E-05
Lead	NA	4.48E-04	3.36E-05	1.74E-03	NA	NA	6.36E-04	1.16E-05	2.87E-03	3.76E-05
Manganese	NA	8.51E-05	7.43E-06	4.86E-03	NA	NA	3.35E-04	1.97E-07	5.29E-03	3.07E-06
Zinc	NA	8.92E-04	8.85E-05	5.35E-02	NA	NA	4.10E-04	1.78E-05	5.49E-02	1.82E-05

Note:

NA = Not Analyzed.

BKD = At Background Levels

Child is assumed to live in Manlove

Table A-12 Maximum Chronic Daily Intake (CDI) Calculation for an East Helena Child

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	1.16E-01	6.00E-04	NA	4.22E-03	4.12E-03	6.27E-04	4.09E-05	1.85E-05	1.26E-01	5.14E-06
Cadmium	1.00E-03	6.60E-06	NA	2.79E-04	3.04E-04	3.84E-04	2.10E-05	3.05E-07	2.00E-03	1.26E-05
Copper	1.29E-03	1.46E-02	NA	1.97E-02	4.05E-02	NA	1.16E-03	2.13E-04	7.75E-02	1.17E-04
Iron	4.43E-02	NA	NA	NA	NA	NA	NA	1.70E-05	4.43E-02	3.30E-05
Lead	1.86E-03	2.84E-03	NA	4.94E-03	2.12E-03	9.97E-03	1.36E-03	2.62E-05	2.31E-02	8.35E-05
Manganese	3.07E+00	1.85E-04	NA	7.19E-03	NA	NA	2.21E-04	4.16E-07	3.08E+00	6.64E-06
Zinc	1.79E-02	7.66E-03	NA	1.04E-01	2.24E-01	1.21E+00	9.76E-04	4.36E-05	1.56E+00	4.10E-05

Note:

NA = Not Analyzed.

BKD = At Background Levels

Child is assumed to live in East Helena

Table A-13 Maximum Chronic Daily Intake (CDI) Calculation for a Manlove Child

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	1.16E-01	6.09E-04	1.14E-04	4.22E-03	4.12E-03	6.27E-04	2.48E-04	1.85E-05	1.26E-01	5.14E-06
Cadmium	1.00E-03	6.71E-06	2.96E-07	2.79E-04	3.04E-04	3.84E-05	4.59E-05	3.05E-07	1.68E-03	1.26E-05
Copper	1.29E-03	1.49E-02	4.01E-05	1.97E-02	4.05E-02	NA	1.24E-03	2.13E-04	7.79E-02	1.17E-04
Iron	4.43E-02	NA	3.24E-04	NA	NA	NA	NA	1.70E-05	4.46E-02	3.30E-05
Lead	1.86E-03	2.88E-03	5.13E-05	4.94E-03	2.12E-03	9.97E-03	2.01E-03	2.62E-05	2.39E-02	8.35E-05
Manganese	3.07E+00	1.88E-04	8.63E-06	7.19E-03	NA	NA	4.94E-04	4.16E-07	3.08E+00	6.64E-06
Zinc	1.79E-02	7.79E-03	1.43E-04	1.04E-01	2.24E-01	1.21E+00	1.46E-03	4.36E-05	1.57E+00	4.10E-05

Note:

NA = Not Analyzed.

BKD = At Background Levels

Child is assumed to live in Manlove

Table A-14 Representative Chronic Daily Intake (CDI) Calculation for an East Helena Youth

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	NA	5.08E-05	2.25E-07	1.97E-03	NA	NA	6.42E-06	4.06E-06	2.03E-03	1.09E-06
Cadmium	NA	4.73E-07	1.02E-09	1.17E-04	NA	NA	2.65E-06	6.79E-08	1.20E-04	1.57E-06
Copper	NA	2.65E-04	5.53E-07	1.22E-02	NA	NA	3.72E-05	4.42E-05	1.25E-02	2.55E-05
Iron	NA	NA	4.48E-05	NA	NA	NA	4.67E-04	3.86E-06	5.16E-04	7.47E-06
Lead	NA	1.43E-04	3.99E-07	1.53E-03	NA	NA	1.21E-04	5.24E-06	1.80E-03	1.69E-05
Manganese	NA	2.71E-05	6.01E-07	4.27E-03	NA	NA	8.18E-05	8.71E-08	4.38E-03	1.35E-06
Zinc	NA	2.84E-04	3.45E-06	4.75E-02	NA	NA	7.76E-05	8.04E-06	4.79E-02	8.17E-06

Note:

NA = Not Analyzed.

BKD = At Background Levels

Youth is assumed to live in East Helena

Table A-15 Representative Chronic Daily Intake (CDI) Calculation for a Manlove Youth

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	NA	4.92E-05	2.99E-05	1.97E-03	NA	NA	2.14E-05	4.06E-06	2.07E-03	1.09E-06
Cadmium	NA	4.58E-07	1.28E-07	1.17E-04	NA	NA	5.66E-06	6.79E-08	1.23E-04	1.57E-06
Copper	NA	2.56E-04	1.76E-05	1.22E-02	NA	NA	4.62E-05	4.42E-05	1.25E-02	2.55E-05
Iron	NA	NA	1.87E-04	NA	NA	NA	3.90E-04	3.86E-06	5.81E-04	7.47E-06
Lead	NA	1.38E-04	2.19E-05	1.53E-03	NA	NA	1.94E-04	5.24E-06	1.89E-03	1.69E-05
Manganese	NA	2.62E-05	4.85E-06	4.27E-03	NA	NA	9.86E-05	8.71E-08	4.40E-03	1.35E-06
Zinc	NA	2.75E-04	5.78E-05	4.75E-02	NA	NA	1.17E-04	8.04E-06	4.80E-02	8.17E-06

Note:

NA = Not Analyzed.

BKD = At Background Levels

Youth is assumed to live in Manlove

Table A-16 Maximum Chronic Daily Intake (CDI) Calculation for an East Helena Youth

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	4.18E-02	1.94E-04	6.03E-07	3.79E-03	1.48E-03	2.25E-04	2.39E-05	8.36E-06	4.75E-02	2.31E-06
Cadmium	3.59E-04	2.14E-06	2.92E-09	2.47E-04	1.09E-04	1.38E-05	1.18E-05	1.38E-07	7.43E-04	3.29E-06
Copper	4.62E-04	4.73E-03	1.28E-06	1.82E-02	1.45E-02	NA	6.37E-04	9.62E-05	3.86E-02	6.37E-05
Iron	1.59E-02	NA	6.28E-05	NA	NA	NA	6.55E-04	7.71E-06	1.66E-02	1.49E-05
Lead	6.67E-04	9.19E-04	1.49E-06	4.37E-03	7.62E-04	3.58E-03	7.65E-04	1.18E-05	1.11E-02	4.43E-05
Manganese	1.10E+00	5.98E-05	1.17E-06	6.38E-03	NA	NA	1.73E-04	1.84E-07	1.11E+00	2.92E-06
Zinc	6.41E-03	2.48E-03	1.02E-05	9.32E-02	8.05E-02	4.33E-01	5.81E-04	1.96E-05	6.16E-01	2.56E-05

Note:

NA = Not Analyzed.

BKD = At Background Levels

Youth is assumed to live in East Helena

Table A-17 Maximum Chronic Daily Intake (CDI) Calculation for a Manlove Youth

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	4.18E-02	1.88E-04	7.47E-05	3.79E-03	1.48E-03	2.25E-04	6.12E-05	8.36E-06	4.76E-02	2.31E-06
Cadmium	3.59E-04	2.07E-06	1.93E-07	2.47E-04	1.09E-04	1.38E-05	1.61E-05	1.38E-07	7.47E-04	3.29E-06
Copper	4.62E-04	4.58E-03	2.62E-05	1.82E-02	1.45E-02	NA	6.49E-04	9.62E-05	3.85E-02	6.37E-05
Iron	1.59E-02	NA	2.11E-04	NA	NA	NA	4.41E-04	7.71E-06	1.66E-02	1.49E-05
Lead	6.67E-04	8.89E-04	3.35E-05	4.37E-03	7.62E-04	3.58E-03	8.60E-04	1.18E-05	1.12E-02	4.43E-05
Manganese	1.10E+00	5.78E-05	5.63E-06	6.38E-03	NA	NA	1.71E-04	1.84E-07	1.11E+00	2.92E-06
Zinc	6.41E-03	2.40E-03	9.36E-05	9.32E-02	8.05E-02	4.33E-01	6.22E-04	1.96E-05	6.16E-01	2.56E-05

Note:

NA = Not Analyzed.

BKD = At Background Levels

Youth is assumed to live in Manlove

Table A-18. Representative Chronic Daily Intake (CDI) Calculation for an Adult

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	NA	2.86E-05	NA	1.10E-03	NA	NA	6.93E-06	2.32E-06	1.14E-03	7.20E-07
Cadmium	NA	2.66E-07	NA	6.51E-05	NA	NA	3.01E-06	3.59E-08	6.84E-05	9.14E-07
Copper	NA	1.49E-04	NA	6.76E-03	NA	NA	4.22E-05	2.31E-05	6.97E-03	1.45E-05
Iron	NA	NA	NA	NA	NA	NA	NA	1.93E-06	1.93E-06	3.73E-06
Lead	NA	8.01E-05	NA	8.55E-04	NA	NA	1.36E-04	3.26E-06	1.07E-03	1.37E-05
Manganese	NA	1.52E-05	NA	2.38E-03	NA	NA	6.47E-05	1.66E-07	2.46E-03	3.17E-06
Zinc	NA	1.60E-04	NA	2.65E-02	NA	NA	7.23E-05	5.18E-06	2.67E-02	7.18E-06

Note:

NA = Not Analyzed.

BKD = At Background Levels

Table A-19 Maximum Chronic Daily Intake (CDI) Calculation for an Adult

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	4.66E-02	1.09E-04	NA	2.11E-03	8.24E-04	1.25E-04	2.65E-05	1.39E-05	4.98E-02	1.84E-06
Cadmium	4.00E-04	1.20E-06	NA	1.37E-04	6.08E-05	7.67E-06	1.36E-05	6.52E-07	6.21E-04	2.22E-06
Copper	5.14E-04	2.66E-03	NA	1.01E-02	8.10E-03	NA	7.53E-04	1.06E-04	2.23E-02	6.41E-05
Iron	1.77E-02	NA	NA	NA	NA	NA	NA	1.31E-05	1.77E-02	7.46E-06
Lead	7.43E-04	5.16E-04	NA	2.44E-03	4.24E-04	1.99E-03	8.77E-04	1.26E-05	7.00E-03	5.60E-05
Manganese	1.23E+00	3.36E-05	NA	3.56E-03	NA	NA	1.43E-04	4.34E-07	1.23E+00	6.96E-06
Zinc	7.14E-03	1.39E-03	NA	5.20E-02	4.48E-02	2.41E-01	6.31E-04	2.36E-05	3.47E-01	3.99E-05

Note:

NA = Not Analyzed.

BKD = At Background Levels

Table A-20 Representative Lifetime Chronic Daily Intake (CDI) Calculation

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	NA	4.22E-05	6.81E-06	1.28E-03	NA	NA	1.60E-05	2.27E-06	1.35E-03	9.05E-07
Cadmium	NA	3.93E-07	2.93E-08	7.58E-05	NA	NA	4.89E-06	3.55E-08	8.12E-05	1.20E-06
Copper	NA	2.20E-04	4.00E-06	7.85E-03	NA	NA	4.45E-05	2.30E-05	8.14E-03	1.93E-05
Iron	NA	NA	4.26E-05	NA	NA	NA	2.21E-04	1.93E-06	2.66E-04	5.22E-06
Lead	NA	1.18E-04	5.00E-06	9.95E-04	NA	NA	1.86E-04	3.14E-06	1.31E-03	1.61E-05
Manganese	NA	2.25E-05	1.10E-06	2.78E-03	NA	NA	9.20E-05	1.44E-07	2.89E-03	3.00E-06
Zinc	NA	2.36E-04	1.32E-05	3.08E-02	NA	NA	1.07E-04	4.97E-06	3.12E-02	8.26E-06

Note:

NA = Not Analyzed.

BKD = At Background Levels

Individual is assumed to live in Manlove

Table A-21 Maximum Lifetime Chronic Daily Intake (CDI) Calculation

Chemical	Intake of Water (mg/kg/day)	Intake of Soil (mg/kg/day)	Intake of Sediments (mg/kg/day)	Intake of Vegetables (mg/kg/day)	Intake of Grain (mg/kg/day)	Intake of Meat (mg/kg/day)	Intake thru Dermal Abs. (mg/kg/day)	Ingestion of Irr. Part. (mg/kg/day)	Intake thru Ingestion (mg/kg/day)	Intake thru Inhalation (mg/kg/day)
Arsenic	5.24E-02	1.61E-04	1.70E-05	2.45E-03	1.18E-03	1.79E-04	4.95E-05	1.37E-05	5.64E-02	5.26E-06
Cadmium	4.50E-04	1.77E-06	4.40E-08	1.60E-04	8.70E-05	1.10E-05	1.68E-05	6.51E-07	7.27E-04	2.09E-05
Copper	5.79E-04	3.93E-03	5.96E-06	1.17E-02	1.16E-02	NA	7.88E-04	1.03E-04	2.87E-02	1.02E-04
Iron	1.99E-02	NA	4.82E-05	NA	NA	NA	2.50E-04	1.31E-05	2.02E-02	3.54E-05
Lead	8.36E-04	7.63E-04	7.63E-06	2.84E-03	6.07E-04	2.86E-03	9.77E-04	1.19E-05	8.90E-03	6.96E-05
Manganese	1.38E+00	4.96E-05	1.28E-06	4.14E-03	NA	NA	1.77E-04	3.85E-07	1.38E+00	7.32E-06
Zinc	8.04E-03	2.06E-03	2.13E-05	6.04E-02	6.42E-02	3.46E-01	7.05E-04	2.18E-05	4.81E-01	4.49E-05

Note:

NA = Not Analyzed.

BKD = At Background Levels

Individual is assumed to live in Manlove

APPENDIX 10-2

CARCINOGENIC AND NONCARCINOGENIC
RISK ASSESSMENT TABLES

The equations used to calculate carcinogenic risks and hazard indices have been modified to account for variations in the different population groups. For example, the CPF for arsenic ingestion is 1.75 $(mg/kg/day)^{-1}$. However, this factor was derived based upon a 70-year exposure. A child would not be well represented by these assumptions. To account for the smaller time interval, a factor of 0.09 (6/70) was used for the child and for the youth. For the adult, a factor of 0.82 (58/70) was used.

With the exception of the CPF for arsenic inhalation, the CPF and RfD values presented in the Health Effects Assessment Summary Tables (HEAST) (EPA, 1989b) are for administered doses. The CPF for arsenic inhalation is already an absorbed dose. Therefore, the toxicity values were adjusted [as described in the Risk Assessment Guidelines for Superfund (RAGGs)] to account for the absorbed dose, where appropriate. For the ingestion values, absorption factors correcting for absorption from drinking water were as follows: arsenic--95 percent, cadmium--5 percent, copper--60 percent, iron--17.5 percent, lead--10 percent, manganese--4 percent, and zinc--30 percent. For inhalation, the correction factors are as follows: cadmium--50 percent, copper--50 percent, iron--50 percent, lead--45 percent, manganese--45 percent, and zinc--50 percent.

REPRESENTATIVE CARCINOGENIC RISKS TO A
CHILD FROM EAST HELENA
TABLES B-1 THROUGH B-7

TABLE B-1. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE CHILD IN EAST HELENA

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.63E-04	1.80E+00	2.51E-05	
2 Cadmium	1.51E-06	NA	0.00E+00	
3 Copper	8.48E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	4.56E-04	ND	0.00E+00	
6 Manganese	8.68E-05	NA	0.00E+00	
7 Zinc	9.10E-04	NA	0.00E+00	
				2.51E-05

TABLE B-2. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.22E-06	5.00E+01	9.51E-06	
2 Cadmium	3.35E-06	1.20E+01	3.45E-06	
3 Copper	5.45E-05	NA	0.00E+00	
4 Iron	1.65E-05	NA	0.00E+00	
5 Lead	3.23E-05	ND	0.00E+00	
6 Manganese	5.38E-07	NA	0.00E+00	
7 Zinc	1.50E-05	NA	0.00E+00	
				1.30E-05

TABLE B-3. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE CHILD IN EAST HELENA

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.81E-07	5.00E+01	7.76E-07	
2 Cadmium	1.31E-07	1.20E+01	1.35E-07	
3 Copper	1.84E-06	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	5.33E-06	ND	0.00E+00	
6 Manganese	2.53E-06	NA	0.00E+00	
7 Zinc	3.15E-06	NA	0.00E+00	
				9.10E-07

TABLE B-4. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE CHILD IN EAST HELENA

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.21E-03	1.80E+00	3.41E-04	
2 Cadmium	1.33E-04	NA	0.00E+00	
3 Copper	1.34E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.74E-03	ND	0.00E+00	
6 Manganese	4.86E-03	NA	0.00E+00	
7 Zinc	5.35E-02	NA	0.00E+00	
				3.41E-04

TABLE B-5. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE CHILD IN EAST HELENA

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.07E-05	1.80E+00	1.65E-06	
2 Cadmium	4.66E-06	NA	0.00E+00	
3 Copper	6.52E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.11E-04	ND	0.00E+00	
6 Manganese	1.00E-04	NA	0.00E+00	
7 Zinc	1.12E-04	NA	0.00E+00	
				1.65E-06

TABLE B-6. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
Arsenic	8.99E-06	1.80E+00	1.39E-06	
Cadmium	1.50E-07	NA	0.00E+00	
Copper	9.76E-05	NA	0.00E+00	
Iron	8.53E-06	NA	0.00E+00	
Lead	1.16E-05	ND	0.00E+00	
Manganese	1.97E-07	NA	0.00E+00	
Zinc	1.78E-05	NA	0.00E+00	
				1.39E-06

TABLE B-7. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE CHILD IN EAST HELENA.

	CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
	1 Arsenic	3.69E-04	1.03E-05	3.79E-04
	2 Cadmium	0.00E+00	3.58E-06	3.58E-06
	3 Copper	0.00E+00	0.00E+00	0.00E+00
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	0.00E+00	0.00E+00	0.00E+00
	7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL		3.69E-04	1.39E-05	3.83E-04

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WORST CASE CARCINOGENIC RISKS TO A
CHILD FROM EAST HELENA
TABLES B-8 THROUGH B-17

TABLE B-8. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	6.00E-04	1.80E+00	9.26E-05	
2 Cadmium	6.60E-06	NA	0.00E+00	
3 Copper	1.46E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.84E-03	ND	0.00E+00	
6 Manganese	1.85E-04	NA	0.00E+00	
7 Zinc	7.66E-03	NA	0.00E+00	
				9.26E-05

TABLE B-9. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.45E-06	5.00E+01	1.91E-05	
2 Cadmium	6.69E-06	1.20E+01	6.88E-06	
3 Copper	1.09E-04	NA	0.00E+00	
4 Iron	3.30E-05	NA	0.00E+00	
5 Lead	6.47E-05	ND	0.00E+00	
6 Manganese	1.05E-06	NA	0.00E+00	
7 Zinc	3.01E-05	NA	0.00E+00	
				2.60E-05

TABLE B-10. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	6.91E-07	5.00E+01	2.96E-06	
2 Cadmium	5.92E-07	1.20E+01	6.09E-07	
3 Copper	3.28E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	3.44E-05	ND	0.00E+00	
6 Manganese	5.59E-06	NA	0.00E+00	
7 Zinc	2.75E-05	NA	0.00E+00	
				3.57E-06

TABLE B-11. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.22E-03	1.80E+00	6.51E-04	
2 Cadmium	2.79E-04	NA	0.00E+00	
3 Copper	1.97E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	4.94E-03	ND	0.00E+00	
6 Manganese	7.19E-03	NA	0.00E+00	
7 Zinc	1.04E-01	NA	0.00E+00	
				6.51E-04

TABLE 6-12. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.09E-05	1.80E+00	6.31E-06	
2 Cadmium	2.10E-05	NA	0.00E+00	
3 Copper	1.16E-03	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.36E-03	ND	0.00E+00	
6 Manganese	2.21E-04	NA	0.00E+00	
7 Zinc	9.76E-04	NA	0.00E+00	
				6.31E-06

TABLE B-13. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.85E-05	1.80E+00	2.85E-06	
2 Cadmium	3.05E-07	NA	0.00E+00	
3 Copper	2.13E-04	NA	0.00E+00	
4 Iron	1.70E-05	NA	0.00E+00	
5 Lead	2.62E-05	ND	0.00E+00	
6 Manganese	4.16E-07	NA	0.00E+00	
7 Zinc	4.36E-05	NA	0.00E+00	
				2.85E-06

TABLE B-14. PATHWAY-SPECIFIC RISK--MEAT CONSMPTION FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	6.27E-04	1.80E+00	9.67E-05	
2 Cadmium	3.84E-04	NA	0.00E+00	
3 Copper	NA	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	9.97E-03	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	1.21E+00	NA	0.00E+00	
				9.67E-05

TABLE B-15. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.16E-01	1.80E+00	1.79E-02	
2 Cadmium	1.00E-03	NA	0.00E+00	
3 Copper	1.29E-03	NA	0.00E+00	
4 Iron	4.43E-02	NA	0.00E+00	
5 Lead	1.86E-03	ND	0.00E+00	
6 Manganese	3.07E+00	NA	0.00E+00	
7 Zinc	1.79E-02	NA	0.00E+00	
				1.79E-02

TABLE B-16. PATHWAY-SPECIFIC RISK--GRAIN CONSMPTION FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.12E-03	1.80E+00	6.36E-04	
2 Cadmium	3.04E-04	NA	0.00E+00	
3 Copper	4.05E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.12E-03	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	2.24E-01	NA	0.00E+00	
				6.36E-04

TABLE B-17. CHEMICAL-SPECIFIC RISK FOR WORST CASE CHILD IN EAST HELENA.

	CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
	1 Arsenic	1.94E-02	2.20E-05	1.94E-02
	2 Cadmium	0.00E+00	7.49E-06	7.49E-06
	3 Copper	0.00E+00	0.00E+00	0.00E+00
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	0.00E+00	0.00E+00	0.00E+00
	7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL		1.94E-02	2.95E-05	1.94E-02

REPRESENTATIVE CARCINOGENIC RISKS TO A
CHILD FROM MANLOVE
TABLES B-18 THROUGH B-27

TABLE B-18. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE CHILD IN MANLOVE

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.60E-04	1.60E+00	2.47E-05	
2 Cadmium	1.49E-06	NA	0.00E+00	
3 Copper	8.32E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	4.48E-04	ND	0.00E+00	
6 Manganese	8.51E-05	NA	0.00E+00	
7 Zinc	8.92E-04	NA	0.00E+00	
				2.47E-05

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TABLE B-19. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE CHILD IN MANLOVE

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.22E-06	5.00E+01	9.51E-06	
2 Cadmium	3.35E-06	1.20E+01	3.45E-06	
3 Copper	5.45E-05	NA	0.00E+00	
4 Iron	1.65E-05	NA	0.00E+00	
5 Lead	3.23E-05	ND	0.00E+00	
6 Manganese	5.38E-07	NA	0.00E+00	
7 Zinc	1.50E-05	NA	0.00E+00	
				1.30E-05

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TABLE B-20. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE CHILD IN MANLOVE

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.81E-07	5.00E+01	7.76E-07	
2 Cadmium	1.31E-07	1.20E+01	1.35E-07	
3 Copper	1.84E-06	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	5.33E-06	ND	0.00E+00	
6 Manganese	2.53E-06	NA	0.00E+00	
7 Zinc	3.15E-06	NA	0.00E+00	
				9.10E-07

TABLE B-21. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.58E-05	1.80E+00	7.07E-06	
2 Cadmium	1.97E-07	NA	0.00E+00	
3 Copper	2.69E-06	NA	0.00E+00	
4 Iron	2.86E-04	NA	0.00E+00	
5 Lead	3.36E-05	ND	0.00E+00	
6 Manganese	7.43E-06	NA	0.00E+00	
7 Zinc	8.85E-05	NA	0.00E+00	
				7.07E-06

TABLE B-22. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	8.26E-05	1.80E+00	1.27E-05	
2 Cadmium	1.66E-05	NA	0.00E+00	
3 Copper	5.67E-05	NA	0.00E+00	
4 Iron	2.07E-03	NA	0.00E+00	
5 Lead	4.25E-04	ND	0.00E+00	
6 Manganese	2.35E-04	NA	0.00E+00	
7 Zinc	2.98E-04	NA	0.00E+00	
				1.27E-05

TABLE B-23. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.21E-03	1.80E+00	3.41E-04	
2 Cadmium	1.33E-04	NA	0.00E+00	
3 Copper	1.34E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.74E-03	ND	0.00E+00	
6 Manganese	4.86E-03	NA	0.00E+00	
7 Zinc	5.35E-02	NA	0.00E+00	
				3.41E-04

TABLE B-24. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.07E-05	1.80E+00	1.65E-06	
2 Cadmium	4.66E-06	NA	0.00E+00	
3 Copper	6.52E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.11E-04	ND	0.00E+00	
6 Manganese	1.00E-04	NA	0.00E+00	
7 Zinc	1.12E-04	NA	0.00E+00	
				1.65E-06

TABLE 25. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	8.99E-06	1.80E+00	1.39E-06	
2 Cadmium	1.50E-07	NA	0.00E+00	
3 Copper	9.76E-05	NA	0.00E+00	
4 Iron	8.53E-06	NA	0.00E+00	
5 Lead	1.16E-05	ND	0.00E+00	
6 Manganese	1.97E-07	NA	0.00E+00	
7 Zinc	1.78E-05	NA	0.00E+00	
				1.39E-06

TABLE B-26. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	3.26E-09	1.80E+00	5.03E-10	
2 Cadmium	4.34E-10	NA	0.00E+00	
3 Copper	2.17E-09	NA	0.00E+00	
4 Iron	2.06E-08	NA	0.00E+00	
5 Lead	2.12E-09	ND	0.00E+00	
6 Manganese	3.72E-08	NA	0.00E+00	
7 Zinc	7.87E-09	NA	0.00E+00	
				5.03E-10

TABLE B-27. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE CHILD IN MANLOVE.

	CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
	1 Arsenic	3.89E-04	1.03E-05	3.99E-04
	2 Cadmium	0.00E+00	3.58E-06	3.58E-06
	3 Copper	0.00E+00	0.00E+00	0.00E+00
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	0.00E+00	0.00E+00	0.00E+00
	7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL		3.89E-04	1.39E-05	4.02E-04

WORST CASE CARCINOGENIC RISKS TO A
CHILD FROM MANLOVE
TABLES B-28 THROUGH B-40

TABLE B-28. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	6.09E-04	1.80E+00	9.40E-05	
2 Cadmium	6.71E-06	NA	0.00E+00	
3 Copper	1.49E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.88E-03	ND	0.00E+00	
6 Manganese	1.88E-04	NA	0.00E+00	
7 Zinc	7.79E-03	NA	0.00E+00	
				9.40E-05

TABLE B-29. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.45E-06	5.00E+01	1.91E-05	
2 Cadmium	6.69E-06	1.20E+01	6.88E-06	
3 Copper	1.09E-04	NA	0.00E+00	
4 Iron	3.30E-05	NA	0.00E+00	
5 Lead	6.47E-05	ND	0.00E+00	
6 Manganese	1.05E-06	NA	0.00E+00	
7 Zinc	3.01E-05	NA	0.00E+00	
				2.60E-05

TABLE 8-30. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	6.91E-07	5.00E+01	2.96E-06	
2 Cadmium	5.92E-07	1.20E+01	6.09E-07	
3 Copper	3.28E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	3.44E-05	ND	0.00E+00	
6 Manganese	5.59E-06	NA	0.00E+00	
7 Zinc	2.75E-05	NA	0.00E+00	
				3.57E-06

TABLE B-31. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR WORST CAST CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.14E-04	1.80E+00	1.76E-05	
2 Cadmium	2.96E-07	NA	0.00E+00	
3 Copper	4.05E-06	NA	0.00E+00	
4 Iron	3.24E-04	NA	0.00E+00	
5 Lead	5.13E-06	ND	0.00E+00	
6 Manganese	8.63E-06	NA	0.00E+00	
7 Zinc	1.43E-04	NA	0.00E+00	
				1.76E-05

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TABLE B-32. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.07E-04	1.80E+00	3.19E-05	
2 Cadmium	2.49E-05	NA	0.00E+00	
3 Copper	8.44E-05	NA	0.00E+00	
4 Iron	2.34E-03	NA	0.00E+00	
5 Lead	6.48E-04	ND	0.00E+00	
6 Manganese	2.73E-04	NA	0.00E+00	
7 Zinc	4.83E-04	NA	0.00E+00	
				3.19E-05

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TABLE B-33. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.22E-03	1.80E+00	6.51E-04	
2 Cadmium	2.79E-04	NA	0.00E+00	
3 Copper	1.97E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	4.94E-03	ND	0.00E+00	
6 Manganese	7.19E-03	NA	0.00E+00	
7 Zinc	1.04E-01	NA	0.00E+00	
				6.51E-04

TABLE B-34. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.09E-05	1.80E+00	6.31E-06	
2 Cadmium	2.10E-05	NA	0.00E+00	
3 Copper	1.16E-03	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.36E-03	ND	0.00E+00	
6 Manganese	2.21E-04	NA	0.00E+00	
7 Zinc	9.76E-04	NA	0.00E+00	
				6.31E-06

TABLE B-35. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.85E-05	1.80E+00	2.85E-06	
2 Cadmium	3.05E-07	NA	0.00E+00	
3 Copper	2.13E-04	NA	0.00E+00	
4 Iron	1.70E-05	NA	0.00E+00	
5 Lead	2.62E-05	ND	0.00E+00	
6 Manganese	4.16E-07	NA	0.00E+00	
7 Zinc	4.36E-05	NA	0.00E+00	
				2.85E-06

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TABLE B-36. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	8.14E-09	1.80E+00	1.26E-09	
2 Cadmium	1.63E-09	NA	0.00E+00	
3 Copper	5.43E-09	NA	0.00E+00	
4 Iron	3.39E-08	NA	0.00E+00	
5 Lead	6.78E-09	ND	0.00E+00	
6 Manganese	4.86E-08	NA	0.00E+00	
7 Zinc	2.82E-08	NA	0.00E+00	
				1.26E-09

TABLE B-37. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	6.27E-04	1.80E+00	9.67E-05	
2 Cadmium	3.84E-05	NA	0.00E+00	
3 Copper	NA	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	9.97E-03	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	1.21E+00	NA	0.00E+00	
				9.67E-05

TABLE B-38. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE CHILD IN MANLOVE

	CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1	Arsenic	1.16E-01	1.80E+00	1.79E-02	
2	Cadmium	1.00E-03	NA	0.00E+00	
3	Copper	1.29E-03	NA	0.00E+00	
4	Iron	4.43E-02	NA	0.00E+00	
5	Lead	1.86E-03	ND	0.00E+00	
6	Manganese	3.07E+00	NA	0.00E+00	
7	Zinc	1.79E-02	NA	0.00E+00	
					1.79E-02

TABLE B-39. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.12E-03	1.80E+00	6.36E-04	
2 Cadmium	3.04E-04	NA	0.00E+00	
3 Copper	4.05E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.12E-03	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	2.24E-01	NA	0.00E+00	
				6.36E-04

TABLE B-40. CHEMICAL-SPECIFIC RISK FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
1 Arsenic	1.94E-02	2.20E-05	1.95E-02
2 Cadmium	0.00E+00	7.49E-06	7.49E-06
3 Copper	0.00E+00	0.00E+00	0.00E+00
4 Iron	0.00E+00	0.00E+00	0.00E+00
5 Lead	0.00E+00	0.00E+00	0.00E+00
6 Manganese	0.00E+00	0.00E+00	0.00E+00
7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL	1.94E-02	2.95E-05	2.00E-02

REPRESENTATIVE CARCINOGENIC RISKS TO
A YOUTH FROM EAST HELENA
TABLES B-41 THROUGH B-50

TABLE B-41. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	5.08E-05	1.80E+00	7.84E-06	
2 Cadmium	4.73E-07	NA	0.00E+00	
3 Copper	2.65E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.43E-04	ND	0.00E+00	
6 Manganese	2.71E-05	NA	0.00E+00	
7 Zinc	2.84E-04	NA	0.00E+00	
				7.84E-06

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TABLE B-42. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.01E-06	5.00E+01	4.33E-06	
2 Cadmium	1.51E-06	1.20E+01	1.55E-06	
3 Copper	2.47E-05	NA	0.00E+00	
4 Iron	7.47E-06	NA	0.00E+00	
5 Lead	1.46E-05	ND	0.00E+00	
6 Manganese	2.43E-07	NA	0.00E+00	
7 Zinc	6.79E-06	NA	0.00E+00	
				5.88E-06

TABLE B-43. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	7.91E-08	5.00E+01	3.39E-07	
2 Cadmium	5.72E-08	1.20E+01	5.88E-08	
3 Copper	8.01E-07	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.33E-06	ND	0.00E+00	
6 Manganese	1.11E-06	NA	0.00E+00	
7 Zinc	1.37E-06	NA	0.00E+00	
				3.98E-07

TABLE B-44. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.97E-03	1.80E+00	3.04E-04	
2 Cadmium	1.17E-04	NA	0.00E+00	
3 Copper	1.22E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.53E-03	ND	0.00E+00	
6 Manganese	4.27E-03	NA	0.00E+00	
7 Zinc	4.75E-02	NA	0.00E+00	
				3.04E-04

TABLE B-45. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	5.83E-06	1.80E+00	8.99E-07	
2 Cadmium	2.53E-06	NA	0.00E+00	
3 Copper	3.55E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.14E-04	ND	0.00E+00	
6 Manganese	5.44E-05	NA	0.00E+00	
7 Zinc	6.08E-05	NA	0.00E+00	
				8.99E-07

TABLE B-46. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.06E-06	1.80E+00	6.26E-07	
2 Cadmium	6.79E-08	NA	0.00E+00	
3 Copper	4.42E-05	NA	0.00E+00	
4 Iron	3.86E-06	NA	0.00E+00	
5 Lead	5.24E-06	ND	0.00E+00	
6 Manganese	8.71E-08	NA	0.00E+00	
7 Zinc	8.04E-06	NA	0.00E+00	
				6.26E-07

TABLE B-47. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.25E-07	1.80E+00	3.47E-08	
2 Cadmium	1.02E-09	NA	0.00E+00	
3 Copper	5.53E-07	NA	0.00E+00	
4 Iron	4.48E-05	NA	0.00E+00	
5 Lead	3.99E-07	ND	0.00E+00	
6 Manganese	6.01E-07	NA	0.00E+00	
7 Zinc	3.45E-06	NA	0.00E+00	
				3.47E-08

TABLE B-48. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	5.87E-07	1.80E+00	9.06E-08	
2 Cadmium	1.24E-07	NA	0.00E+00	
3 Copper	1.68E-06	NA	0.00E+00	
4 Iron	4.67E-04	NA	0.00E+00	
5 Lead	7.28E-06	ND	0.00E+00	
6 Manganese	2.74E-05	NA	0.00E+00	
7 Zinc	1.68E-05	NA	0.00E+00	
				9.06E-08

TABLE B-49. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	5.03E-10	1.80E+00	7.76E-11	
2 Cadmium	1.57E-10	NA	0.00E+00	
3 Copper	2.20E-10	NA	0.00E+00	
4 Iron	2.11E-09	NA	0.00E+00	
5 Lead	1.89E-10	ND	0.00E+00	
6 Manganese	2.26E-09	NA	0.00E+00	
7 Zinc	1.13E-09	NA	0.00E+00	
				7.76E-11

TABLE B-50. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE YOUTH IN EAST HELENA

	CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
	1 Arsenic	3.13E-04	4.67E-06	3.18E-04
	2 Cadmium	0.00E+00	1.61E-06	1.61E-06
	3 Copper	0.00E+00	0.00E+00	0.00E+00
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	0.00E+00	0.00E+00	0.00E+00
	7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL		3.13E-04	6.28E-06	3.20E-04

WORST CASE CARCINOGENIC RISKS TO A
YOUTH FROM EAST HELENA
TABLE B-51 THROUGH B-63

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TABLE B-51. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.94E-04	1.80E+00	2.99E-05	
2 Cadmium	2.14E-06	NA	0.00E+00	
3 Copper	4.73E-03	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	9.19E-04	ND	0.00E+00	
6 Manganese	5.98E-05	NA	0.00E+00	
7 Zinc	2.48E-03	NA	0.00E+00	
				2.99E-05

TABLE B-52. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.01E-06	5.00E+01	8.61E-06	
2 Cadmium	3.03E-06	1.20E+01	3.12E-06	
3 Copper	4.94E-05	NA	0.00E+00	
4 Iron	1.49E-05	NA	0.00E+00	
5 Lead	2.93E-05	ND	0.00E+00	
6 Manganese	4.77E-07	NA	0.00E+00	
7 Zinc	1.36E-05	NA	0.00E+00	
				1.17E-05

TABLE B-53. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	3.02E-07	5.00E+01	1.29E-06	
2 Cadmium	2.58E-07	1.20E+01	2.65E-07	
3 Copper	1.43E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.50E-05	ND	0.00E+00	
6 Manganese	2.44E-06	NA	0.00E+00	
7 Zinc	1.20E-05	NA	0.00E+00	
				1.56E-06

TABLE B-54. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	3.79E-03	1.80E+00	5.85E-04	
2 Cadmium	2.47E-04	NA	0.00E+00	
3 Copper	1.82E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	4.37E-03	ND	0.00E+00	
6 Manganese	6.38E-03	NA	0.00E+00	
7 Zinc	9.32E-02	NA	0.00E+00	
				5.85E-04

TABLE B-55. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.23E-05	1.80E+00	3.44E-06	
2 Cadmium	1.14E-05	NA	0.00E+00	
3 Copper	6.33E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	7.38E-04	ND	0.00E+00	
6 Manganese	1.20E-04	NA	0.00E+00	
7 Zinc	5.31E-04	NA	0.00E+00	
				3.44E-06

TABLE B-56. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR YOUTH IN EAST YOUTH

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	8.36E-06	1.80E+00	1.29E-06	
2 Cadmium	1.38E-07	NA	0.00E+00	
3 Copper	9.62E-05	NA	0.00E+00	
4 Iron	7.71E-06	NA	0.00E+00	
5 Lead	1.18E-05	ND	0.00E+00	
6 Manganese	1.84E-07	NA	0.00E+00	
7 Zinc	1.96E-05	NA	0.00E+00	
				1.29E-06

TABLE B-57. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	6.03E-07	1.80E+00	9.30E-08	
2 Cadmium	2.92E-09	NA	0.00E+00	
3 Copper	1.28E-06	NA	0.00E+00	
4 Iron	6.28E-05	NA	0.00E+00	
5 Lead	1.49E-06	ND	0.00E+00	
6 Manganese	1.17E-06	NA	0.00E+00	
7 Zinc	1.02E-05	NA	0.00E+00	
				9.30E-08

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TABLE B-58. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.57E-06	1.80E+00	2.42E-07	
2 Cadmium	3.56E-07	NA	0.00E+00	
3 Copper	3.65E-06	NA	0.00E+00	
4 Iron	6.55E-04	NA	0.00E+00	
5 Lead	2.71E-05	ND	0.00E+00	
6 Manganese	5.33E-05	NA	0.00E+00	
7 Zinc	4.96E-05	NA	0.00E+00	
				2.42E-07

TABLE B-59. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.48E-09	1.80E+00	3.83E-10	
2 Cadmium	3.46E-10	NA	0.00E+00	
3 Copper	2.83E-10	NA	0.00E+00	
4 Iron	4.09E-09	NA	0.00E+00	
5 Lead	6.29E-09	ND	0.00E+00	
6 Manganese	8.77E-09	NA	0.00E+00	
7 Zinc	2.58E-09	NA	0.00E+00	
				3.83E-10

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TABLE B-60. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.25E-04	1.80E+00	3.47E-05	
2 Cadmium	1.38E-05	NA	0.00E+00	
3 Copper	NA	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	3.58E-03	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	4.33E-01	NA	0.00E+00	
				3.47E-05

TABLE B-61. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.18E-02	1.80E+00	6.45E-03	
2 Cadmium	3.59E-04	NA	0.00E+00	
3 Copper	4.62E-04	NA	0.00E+00	
4 Iron	1.59E-02	NA	0.00E+00	
5 Lead	6.67E-04	ND	0.00E+00	
6 Manganese	1.10E+00	NA	0.00E+00	
7 Zinc	6.41E-03	NA	0.00E+00	
				6.45E-03

TABLE B-62. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE YOUTH IN EAST HELENA

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.48E-03	1.80E+00	2.28E-04	
2 Cadmium	1.09E-04	NA	0.00E+00	
3 Copper	1.45E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	7.62E-04	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	8.05E-02	NA	0.00E+00	
				2.28E-04

TABLE B-63. CHEMICAL-SPECIFIC RISK FOR WORST CASE YOUTH IN EAST HELENA.

	CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
	1 Arsenic	7.33E-03	9.91E-06	7.34E-03
	2 Cadmium	0.00E+00	3.38E-06	3.38E-06
	3 Copper	0.00E+00	0.00E+00	0.00E+00
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	0.00E+00	0.00E+00	0.00E+00
	7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL		7.33E-03	1.33E-05	7.35E-03

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REPRESENTATIVE CARCINOGENIC RISKS TO
A YOUTH FROM MANLOVE
TABLES B-64 THROUGH B-73

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TABLE B-64. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.92E-05	1.80E+00	7.59E-06	
2 Cadmium	4.58E-07	NA	0.00E+00	
3 Copper	2.56E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.38E-04	ND	0.00E+00	
6 Manganese	2.62E-05	NA	0.00E+00	
7 Zinc	2.75E-04	NA	0.00E+00	
				7.59E-06

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TABLE B-65. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.01E-06	5.00E+01	4.33E-06	
2 Cadmium	1.51E-06	1.20E+01	1.55E-06	
3 Copper	2.47E-05	NA	0.00E+00	
4 Iron	7.47E-06	NA	0.00E+00	
5 Lead	1.46E-05	ND	0.00E+00	
6 Manganese	2.43E-07	NA	0.00E+00	
7 Zinc	6.79E-06	NA	0.00E+00	
				5.88E-06

TABLE B-66. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	7.91E-08	5.00E+01	3.39E-07	
2 Cadmium	5.72E-08	1.20E+01	5.88E-08	
3 Copper	8.01E-07	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.33E-06	ND	0.00E+00	
6 Manganese	1.11E-06	NA	0.00E+00	
7 Zinc	1.37E-06	NA	0.00E+00	
				3.98E-07

TABLE B-67. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.99E-05	1.80E+00	4.61E-06	
2 Cadmium	1.28E-07	NA	0.00E+00	
3 Copper	1.76E-05	NA	0.00E+00	
4 Iron	1.87E-04	NA	0.00E+00	
5 Lead	2.19E-05	ND	0.00E+00	
6 Manganese	4.85E-06	NA	0.00E+00	
7 Zinc	5.78E-05	NA	0.00E+00	
				4.61E-06

TABLE B-68. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.56E-05	1.80E+00	2.41E-06	
2 Cadmium	3.13E-06	NA	0.00E+00	
3 Copper	1.07E-05	NA	0.00E+00	
4 Iron	3.90E-04	NA	0.00E+00	
5 Lead	8.00E-05	ND	0.00E+00	
6 Manganese	4.42E-05	NA	0.00E+00	
7 Zinc	5.62E-05	NA	0.00E+00	
				2.41E-06

TABLE B-69. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.97E-03	1.80E+00	3.04E-04	
2 Cadmium	1.17E-04	NA	0.00E+00	
3 Copper	1.22E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.53E-03	ND	0.00E+00	
6 Manganese	4.27E-03	NA	0.00E+00	
7 Zinc	4.75E-02	NA	0.00E+00	
				3.04E-04

TABLE B-70. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	5.83E-06	1.80E+00	8.99E-07	
2 Cadmium	2.53E-06	NA	0.00E+00	
3 Copper	3.55E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.14E-04	ND	0.00E+00	
6 Manganese	5.44E-05	NA	0.00E+00	
7 Zinc	6.08E-05	NA	0.00E+00	
				8.99E-07

TABLE B-71. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.06E-06	1.80E+00	6.26E-07	
2 Cadmium	6.79E-08	NA	0.00E+00	
3 Copper	4.42E-05	NA	0.00E+00	
4 Iron	3.86E-06	NA	0.00E+00	
5 Lead	5.24E-06	ND	0.00E+00	
6 Manganese	8.71E-08	NA	0.00E+00	
7 Zinc	8.04E-06	NA	0.00E+00	
				6.26E-07

TABLE B-72. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.32E-09	1.80E+00	2.04E-10	
2 Cadmium	1.76E-10	NA	0.00E+00	
3 Copper	8.78E-10	NA	0.00E+00	
4 Iron	8.34E-09	NA	0.00E+00	
5 Lead	8.56E-10	ND	0.00E+00	
6 Manganese	1.50E-08	NA	0.00E+00	
7 Zinc	3.18E-09	NA	0.00E+00	
				2.04E-10

TABLE B-73. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
1 Arsenic	3.20E-04	4.67E-06	3.25E-04
2 Cadmium	0.00E+00	1.61E-06	1.61E-06
3 Copper	0.00E+00	0.00E+00	0.00E+00
4 Iron	0.00E+00	0.00E+00	0.00E+00
5 Lead	0.00E+00	0.00E+00	0.00E+00
6 Manganese	0.00E+00	0.00E+00	0.00E+00
7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL	3.20E-04	6.28E-06	3.26E-04

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WORST CASE CARCINOGENICA RISKS TO
A YOUTH FROM MANLOVE
TABLES B-74 THROUGH B-86

TABLE B-74. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.88E-04	1.80E+00	2.90E-05	
2 Cadmium	2.07E-06	NA	0.00E+00	
3 Copper	4.58E-03	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	8.89E-04	ND	0.00E+00	
6 Manganese	5.78E-05	NA	0.00E+00	
7 Zinc	2.40E-03	NA	0.00E+00	
				2.90E-05

TABLE B-75. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.01E-06	5.00E+01	8.61E-06	
2 Cadmium	3.03E-06	1.20E+01	3.12E-06	
3 Copper	4.94E-05	NA	0.00E+00	
4 Iron	1.49E-05	NA	0.00E+00	
5 Lead	2.93E-05	ND	0.00E+00	
6 Manganese	4.77E-07	NA	0.00E+00	
7 Zinc	1.36E-05	NA	0.00E+00	
				1.17E-05

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TABLE B-76. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	3.02E-07	5.00E+01	1.29E-06	
2 Cadmium	2.58E-07	1.20E+01	2.65E-07	
3 Copper	1.43E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.50E-05	ND	0.00E+00	
6 Manganese	2.44E-06	NA	0.00E+00	
7 Zinc	1.20E-05	NA	0.00E+00	
				1.56E-06

TABLE B-76. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	3.02E-07	1.70E+02	4.40E-06	
2 Cadmium	2.58E-07	1.20E+01	2.65E-07	
3 Copper	1.43E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.50E-05	ND	0.00E+00	
6 Manganese	2.44E-06	NA	0.00E+00	
7 Zinc	1.20E-05	NA	0.00E+00	
				4.67E-06

TABLE B-77. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	7.47E-05	1.80E+00	1.15E-05	
2 Cadmium	1.93E-07	NA	0.00E+00	
3 Copper	2.62E-05	NA	0.00E+00	
4 Iron	2.11E-04	NA	0.00E+00	
5 Lead	3.35E-05	ND	0.00E+00	
6 Manganese	5.63E-06	NA	0.00E+00	
7 Zinc	9.36E-05	NA	0.00E+00	
				1.15E-05

TABLE B-78. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	3.89E-05	1.80E+00	6.00E-06	
2 Cadmium	4.70E-06	NA	0.00E+00	
3 Copper	1.59E-05	NA	0.00E+00	
4 Iron	4.41E-04	NA	0.00E+00	
5 Lead	1.22E-04	ND	0.00E+00	
6 Manganese	5.14E-05	NA	0.00E+00	
7 Zinc	9.10E-05	NA	0.00E+00	
				6.00E-06

TABLE B-79. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	3.79E-03	1.80E+00	5.85E-04	
2 Cadmium	2.47E-04	NA	0.00E+00	
3 Copper	1.82E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	4.37E-03	ND	0.00E+00	
6 Manganese	6.38E-03	NA	0.00E+00	
7 Zinc	9.32E-02	NA	0.00E+00	
				5.85E-04

TABLE B-80. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.23E-05	1.80E+00	3.44E-06	
2 Cadmium	1.14E-05	NA	0.00E+00	
3 Copper	6.33E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	7.38E-04	ND	0.00E+00	
6 Manganese	1.20E-04	NA	0.00E+00	
7 Zinc	5.31E-04	NA	0.00E+00	
				3.44E-06

TABLE B-81. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	8.36E-06	1.80E+00	1.29E-06	
2 Cadmium	1.38E-07	NA	0.00E+00	
3 Copper	9.62E-05	NA	0.00E+00	
4 Iron	7.71E-06	NA	0.00E+00	
5 Lead	1.18E-05	ND	0.00E+00	
6 Manganese	1.84E-07	NA	0.00E+00	
7 Zinc	1.96E-05	NA	0.00E+00	
				1.29E-06

TABLE B-82. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	3.29E-09	1.80E+00	5.08E-10	
2 Cadmium	6.59E-10	NA	0.00E+00	
3 Copper	2.20E-09	NA	0.00E+00	
4 Iron	1.37E-08	NA	0.00E+00	
5 Lead	2.74E-09	ND	0.00E+00	
6 Manganese	1.97E-08	NA	0.00E+00	
7 Zinc	1.14E-08	NA	0.00E+00	
				5.08E-10

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TABLE B-83. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.25E-04	1.80E+00	3.47E-05	
2 Cadmium	1.38E-05	NA	0.00E+00	
3 Copper	NA	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	3.58E-03	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	4.33E-01	NA	0.00E+00	
				3.47E-05

TABLE B-84. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.18E-02	1.80E+00	6.45E-03	
2 Cadmium	3.59E-04	NA	0.00E+00	
3 Copper	4.62E-04	NA	0.00E+00	
4 Iron	1.59E-02	NA	0.00E+00	
5 Lead	6.67E-04	ND	0.00E+00	
6 Manganese	1.10E+00	NA	0.00E+00	
7 Zinc	6.41E-03	NA	0.00E+00	
				6.45E-03

TABLE B-85. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.48E-03	1.80E+00	2.28E-04	
2 Cadmium	1.09E-04	NA	0.00E+00	
3 Copper	1.45E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	7.62E-04	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	8.05E-02	NA	0.00E+00	
				2.28E-04

TABLE B-86. CHEMICAL-SPECIFIC RISK FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
1 Arsenic	7.35E-03	9.91E-06	7.36E-03
2 Cadmium	0.00E+00	3.38E-06	3.38E-06
3 Copper	0.00E+00	0.00E+00	0.00E+00
4 Iron	0.00E+00	0.00E+00	0.00E+00
5 Lead	0.00E+00	0.00E+00	0.00E+00
6 Manganese	0.00E+00	0.00E+00	0.00E+00
7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL	7.35E-03	1.33E-05	7.36E-03

REPRESENTATIVE CARCINOGENIC RISKS
TO AN ADULT
TABLES B-87 THROUGH B-93

TABLE B-87. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	5.03E-07	5.00E+01	2.08E-05	
2 Cadmium	7.56E-07	1.20E+01	7.52E-06	
3 Copper	1.23E-05	NA	0.00E+00	
4 Iron	3.73E-06	NA	0.00E+00	
5 Lead	7.29E-06	ND	0.00E+00	
6 Manganese	1.22E-07	NA	0.00E+00	
7 Zinc	3.39E-06	NA	0.00E+00	
				2.84E-05

TABLE B-88. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE CHILD

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.18E-07	5.00E+01	9.03E-06	
2 Cadmium	1.58E-07	1.20E+01	1.57E-06	
3 Copper	2.21E-06	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	6.41E-06	ND	0.00E+00	
6 Manganese	3.05E-06	NA	0.00E+00	
7 Zinc	3.79E-06	NA	0.00E+00	
				1.06E-05

TABLE B-89. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.86E-05	1.80E+00	4.27E-05	
2 Cadmium	2.66E-07	NA	0.00E+00	
3 Copper	1.49E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	8.01E-05	ND	0.00E+00	
6 Manganese	1.52E-05	NA	0.00E+00	
7 Zinc	1.60E-04	NA	0.00E+00	
				4.27E-05

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TABLE B-90. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.10E-03	1.80E+00	1.64E-03	
2 Cadmium	6.51E-05	NA	0.00E+00	
3 Copper	6.76E-03	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	8.55E-04	ND	0.00E+00	
6 Manganese	2.38E-03	NA	0.00E+00	
7 Zinc	2.65E-02	NA	0.00E+00	
				1.64E-03

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TABLE B-91. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	6.93E-06	1.80E+00	1.03E-05	
2 Cadmium	3.01E-06	NA	0.00E+00	
3 Copper	4.22E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.36E-04	ND	0.00E+00	
6 Manganese	6.47E-05	NA	0.00E+00	
7 Zinc	7.23E-05	NA	0.00E+00	
				1.03E-05

TABLE B-92. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.32E-06	1.80E+00	3.46E-06	
2 Cadmium	3.59E-08	NA	0.00E+00	
3 Copper	2.31E-05	NA	0.00E+00	
4 Iron	1.93E-06	NA	0.00E+00	
5 Lead	3.26E-06	ND	0.00E+00	
6 Manganese	1.66E-07	NA	0.00E+00	
7 Zinc	5.18E-06	NA	0.00E+00	
				3.46E-06

TABLE B-93. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE ADULT.

	CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
	1 Arsenic	1.70E-03	2.99E-05	1.73E-03
	2 Cadmium	0.00E+00	9.09E-06	9.09E-06
	3 Copper	0.00E+00	0.00E+00	0.00E+00
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	0.00E+00	0.00E+00	0.00E+00
	7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL		1.70E-03	3.90E-05	1.74E-03

WORST CASE CARCINOGENIC RISKS
TO AN ADULT
TABLES B-94 THROUGH B-103

TABLE B-94. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	3.21E-06	5.00E+01	1.33E-04	
2 Cadmium	1.45E-05	1.20E+01	1.44E-04	
3 Copper	4.67E-05	NA	0.00E+00	
4 Iron	2.53E-05	NA	0.00E+00	
5 Lead	2.23E-05	ND	0.00E+00	
6 Manganese	7.73E-07	NA	0.00E+00	
7 Zinc	1.02E-05	NA	0.00E+00	
				2.77E-04

TABLE B-95. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	8.32E-07	5.00E+01	3.45E-05	
2 Cadmium	7.12E-07	1.20E+01	7.08E-06	
3 Copper	3.94E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	4.13E-05	ND	0.00E+00	
6 Manganese	6.72E-06	NA	0.00E+00	
7 Zinc	3.31E-05	NA	0.00E+00	
				4.15E-05

TABLE B-96. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.09E-04	1.80E+00	1.63E-04	
2 Cadmium	1.20E-06	NA	0.00E+00	
3 Copper	2.66E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	5.16E-04	ND	0.00E+00	
6 Manganese	3.36E-05	NA	0.00E+00	
7 Zinc	1.39E-03	NA	0.00E+00	
				1.63E-04

TABLE B-97. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.11E-03	1.80E+00	3.15E-03	
2 Cadmium	1.37E-04	NA	0.00E+00	
3 Copper	1.01E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.44E-03	ND	0.00E+00	
6 Manganese	3.56E-03	NA	0.00E+00	
7 Zinc	5.20E-02	NA	0.00E+00	
				3.15E-03

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TABLE B-98. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.65E-05	1.80E+00	3.95E-05	
2 Cadmium	1.36E-05	NA	0.00E+00	
3 Copper	7.53E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	8.77E-04	ND	0.00E+00	
6 Manganese	1.43E-04	NA	0.00E+00	
7 Zinc	6.31E-04	NA	0.00E+00	
				3.95E-05

TABLE B-99. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.39E-05	1.80E+00	2.07E-05	
2 Cadmium	6.52E-07	NA	0.00E+00	
3 Copper	1.06E-04	NA	0.00E+00	
4 Iron	1.31E-05	NA	0.00E+00	
5 Lead	1.26E-05	ND	0.00E+00	
6 Manganese	4.34E-07	NA	0.00E+00	
7 Zinc	2.36E-05	NA	0.00E+00	
				2.07E-05

TABLE B-100. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.25E-04	1.80E+00	1.86E-04	
2 Cadmium	7.67E-06	NA	0.00E+00	
3 Copper	NA	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.99E-03	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	2.41E-01	NA	0.00E+00	
				1.86E-04

TABLE B-101. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.66E-02	1.80E+00	6.95E-02	
2 Cadmium	4.00E-04	NA	0.00E+00	
3 Copper	5.14E-04	NA	0.00E+00	
4 Iron	1.77E-02	NA	0.00E+00	
5 Lead	7.43E-04	ND	0.00E+00	
6 Manganese	1.23E+00	NA	0.00E+00	
7 Zinc	7.14E-03	NA	0.00E+00	
				6.95E-02

TABLE B-102. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	8.24E-04	1.80E+00	1.23E-03	
2 Cadmium	6.08E-05	NA	0.00E+00	
3 Copper	8.10E-03	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	4.24E-04	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	4.48E-02	NA	0.00E+00	
				1.23E-03

TABLE B-103. CHEMICAL-SPECIFIC RISK FOR WORST CASE ADULT.

	CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
	1 Arsenic	7.43E-02	1.67E-04	7.45E-02
	2 Cadmium	0.00E+00	1.51E-04	1.51E-04
	3 Copper	0.00E+00	0.00E+00	0.00E+00
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	0.00E+00	0.00E+00	0.00E+00
	7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL		7.43E-02	3.19E-04	7.46E-02

REPRESENTATIVE CARCINOGENIC LIFETIME RISKS
TO A PERSON FROM MANLOVE
TABLES B-104 THROUGH B-113

TABLE B-104. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.22E-05	1.80E+00	7.60E-05	
2 Cadmium	3.93E-07	NA	0.00E+00	
3 Copper	2.20E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.18E-04	ND	0.00E+00	
6 Manganese	2.25E-05	NA	0.00E+00	
7 Zinc	2.36E-04	NA	0.00E+00	
				7.60E-05

TABLE B-105. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	7.03E-07	5.00E+01	3.52E-05	
2 Cadmium	1.06E-06	1.20E+01	1.27E-05	
3 Copper	1.72E-05	NA	0.00E+00	
4 Iron	5.22E-06	NA	0.00E+00	
5 Lead	1.02E-05	ND	0.00E+00	
6 Manganese	1.70E-07	NA	0.00E+00	
7 Zinc	4.74E-06	NA	0.00E+00	
				4.79E-05

TABLE B-106. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.02E-07	5.00E+01	1.01E-05	
2 Cadmium	1.46E-07	1.20E+01	1.75E-06	
3 Copper	2.05E-06	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	5.95E-06	ND	0.00E+00	
6 Manganese	2.83E-06	NA	0.00E+00	
7 Zinc	3.51E-06	NA	0.00E+00	
				1.19E-05

TABLE B-107. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	6.81E-06	1.80E+00	1.23E-05	
2 Cadmium	2.93E-08	NA	0.00E+00	
3 Copper	4.00E-06	NA	0.00E+00	
4 Iron	4.26E-05	NA	0.00E+00	
5 Lead	5.00E-06	ND	0.00E+00	
6 Manganese	1.10E-06	NA	0.00E+00	
7 Zinc	1.32E-05	NA	0.00E+00	
				1.23E-05

TABLE B-108. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.28E-03	1.80E+00	2.30E-03	
2 Cadmium	7.58E-05	NA	0.00E+00	
3 Copper	7.85E-03	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	9.95E-04	ND	0.00E+00	
6 Manganese	2.78E-03	NA	0.00E+00	
7 Zinc	3.08E-02	NA	0.00E+00	
				2.30E-03

TABLE B-109. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	8.84E-06	1.80E+00	1.59E-05	
2 Cadmium	1.77E-06	NA	0.00E+00	
3 Copper	6.07E-06	NA	0.00E+00	
4 Iron	2.21E-04	NA	0.00E+00	
5 Lead	4.54E-05	ND	0.00E+00	
6 Manganese	2.51E-05	NA	0.00E+00	
7 Zinc	3.19E-05	NA	0.00E+00	
				1.59E-05

TABLE B-110. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	7.17E-06	1.80E+00	1.29E-05	
2 Cadmium	3.12E-06	NA	0.00E+00	
3 Copper	4.36E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	1.41E-04	ND	0.00E+00	
6 Manganese	6.69E-05	NA	0.00E+00	
7 Zinc	7.49E-05	NA	0.00E+00	
				1.29E-05

TABLE B-111. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.27E-06	1.80E+00	4.09E-06	
2 Cadmium	3.55E-08	NA	0.00E+00	
3 Copper	2.30E-05	NA	0.00E+00	
4 Iron	1.93E-06	NA	0.00E+00	
5 Lead	3.14E-06	ND	0.00E+00	
6 Manganese	1.44E-07	NA	0.00E+00	
7 Zinc	4.97E-06	NA	0.00E+00	
				4.09E-06

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TABLE B-112. PATHWAY-SPECIFIC RISK--DERMAL EXOSURE DURING SWIMMING
REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.12E-10	1.80E+00	7.42E-10	
2 Cadmium	5.49E-11	NA	0.00E+00	
3 Copper	2.74E-10	NA	0.00E+00	
4 Iron	2.61E-09	NA	0.00E+00	
5 Lead	2.67E-10	ND	0.00E+00	
6 Manganese	4.70E-09	NA	0.00E+00	
7 Zinc	9.95E-10	NA	0.00E+00	
				7.42E-10

TABLE B-113. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE LIFETIME IN MANLOVE

CHEMICAL	RISK-ING UNITLESS	RISK-INH UNITLESS	TOTAL RISK UNITLESS
1 Arsenic	2.43E-03	4.53E-05	2.47E-03
2 Cadmium	0.00E+00	1.45E-05	1.45E-05
3 Copper	0.00E+00	0.00E+00	0.00E+00
4 Iron	0.00E+00	0.00E+00	0.00E+00
5 Lead	0.00E+00	0.00E+00	0.00E+00
6 Manganese	0.00E+00	0.00E+00	0.00E+00
7 Zinc	0.00E+00	0.00E+00	0.00E+00
TOTAL	2.43E-03	5.97E-05	2.48E-03

WORST CASE CARCINOGENIC LIFETIME RISKS
TO A PERSON FROM MANLOVE
TABLES B-114 THROUGH B-126

TABLE B-114. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.61E-04	1.80E+00	2.90E-04	
2 Cadmium	1.77E-06	NA	0.00E+00	
3 Copper	3.93E-03	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	7.63E-04	ND	0.00E+00	
6 Manganese	4.96E-05	NA	0.00E+00	
7 Zinc	2.06E-03	NA	0.00E+00	
				2.90E-04

TABLE B-115. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	4.49E-06	5.00E+01	2.25E-04	
2 Cadmium	2.02E-05	1.20E+01	2.42E-04	
3 Copper	6.53E-05	NA	0.00E+00	
4 Iron	3.54E-05	NA	0.00E+00	
5 Lead	3.12E-05	ND	0.00E+00	
6 Manganese	1.08E-06	NA	0.00E+00	
7 Zinc	1.42E-05	NA	0.00E+00	
				4.67E-04

TABLE B-116. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	7.71E-07	5.00E+01	3.86E-05	
2 Cadmium	6.60E-07	1.20E+01	7.92E-06	
3 Copper	3.66E-05	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	3.83E-05	ND	0.00E+00	
6 Manganese	6.24E-06	NA	0.00E+00	
7 Zinc	3.07E-05	NA	0.00E+00	
				4.65E-05

TABLE B-117. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.70E-05	1.80E+00	3.06E-05	
2 Cadmium	4.40E-08	NA	0.00E+00	
3 Copper	5.96E-06	NA	0.00E+00	
4 Iron	4.82E-05	NA	0.00E+00	
5 Lead	7.63E-06	ND	0.00E+00	
6 Manganese	1.28E-06	NA	0.00E+00	
7 Zinc	2.13E-05	NA	0.00E+00	
				3.06E-05

TABLE B-118. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.45E-03	1.80E+00	4.41E-03	
2 Cadmium	1.60E-04	NA	0.00E+00	
3 Copper	1.17E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.84E-03	ND	0.00E+00	
6 Manganese	4.14E-03	NA	0.00E+00	
7 Zinc	6.04E-02	NA	0.00E+00	
				4.41E-03

TABLE B-119. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.21E-05	1.80E+00	3.98E-05	
2 Cadmium	2.67E-06	NA	0.00E+00	
3 Copper	9.03E-06	NA	0.00E+00	
4 Iron	2.50E-04	NA	0.00E+00	
5 Lead	6.93E-05	ND	0.00E+00	
6 Manganese	2.92E-05	NA	0.00E+00	
7 Zinc	5.17E-05	NA	0.00E+00	
				3.98E-05

TABLE B-120. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	2.74E-05	1.80E+00	4.93E-05	
2 Cadmium	1.41E-05	NA	0.00E+00	
3 Copper	7.79E-04	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	9.08E-04	ND	0.00E+00	
6 Manganese	1.48E-04	NA	0.00E+00	
7 Zinc	6.53E-04	NA	0.00E+00	
				4.93E-05

TABLE B-121. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.37E-05	1.80E+00	2.47E-05	
2 Cadmium	6.51E-07	NA	0.00E+00	
3 Copper	1.03E-04	NA	0.00E+00	
4 Iron	1.31E-05	NA	0.00E+00	
5 Lead	1.19E-05	ND	0.00E+00	
6 Manganese	3.85E-07	NA	0.00E+00	
7 Zinc	2.18E-05	NA	0.00E+00	
				2.47E-05

TABLE B-152. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
Arsenic	3.26E-09	9.50E-04	2.94E-07	
Cadmium	4.34E-10	5.00E-05	7.44E-07	
Copper	2.17E-09	2.20E-02	8.45E-09	
Iron	2.06E-08	ND	0.00E+00	
Lead	2.12E-09	ND	0.00E+00	
Manganese	3.72E-08	8.00E-03	3.99E-07	
Zinc	7.87E-09	6.00E-02	1.12E-08	
				1.46E-06

TABLE B-153. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE CHILD IN MANLOVE.

	CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
	1 Arsenic	2.27E-01	0.00E+00	2.27E-01
	2 Cadmium	2.68E-01	0.00E+00	2.68E-01
	3 Copper	5.63E-02	0.00E+00	5.63E-02
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	5.67E-02	1.88E-03	5.85E-02
	7 Zinc	7.84E-02	0.00E+00	7.84E-02
TOTAL		6.86E-01	1.88E-03	6.88E-01

TABLE B-122. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.03E-09	1.80E+00	1.85E-09	
2 Cadmium	2.06E-10	NA	0.00E+00	
3 Copper	6.86E-10	NA	0.00E+00	
4 Iron	4.29E-09	NA	0.00E+00	
5 Lead	8.57E-10	ND	0.00E+00	
6 Manganese	6.14E-09	NA	0.00E+00	
7 Zinc	3.57E-09	NA	0.00E+00	
				1.85E-09

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TABLE B-123. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.79E-04	1.80E+00	3.22E-04	
2 Cadmium	1.10E-05	NA	0.00E+00	
3 Copper	NA	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	2.86E-03	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	3.46E-01	NA	0.00E+00	
				3.22E-04

TABLE B-124. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	5.24E-02	1.80E+00	9.43E-02	
2 Cadmium	4.50E-04	NA	0.00E+00	
3 Copper	5.79E-04	NA	0.00E+00	
4 Iron	1.99E-02	NA	0.00E+00	
5 Lead	8.36E-04	ND	0.00E+00	
6 Manganese	1.38E+00	NA	0.00E+00	
7 Zinc	8.04E-03	NA	0.00E+00	
				9.43E-02

TABLE B-125. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	SF 1/(MG/KG/DAY)	CHEMICAL RISK UNITLESS	PATHWAY RISK UNITLESS
1 Arsenic	1.18E-03	1.80E+00	2.12E-03	
2 Cadmium	8.70E-05	NA	0.00E+00	
3 Copper	1.16E-02	NA	0.00E+00	
4 Iron	NA	NA	0.00E+00	
5 Lead	6.07E-04	ND	0.00E+00	
6 Manganese	NA	NA	0.00E+00	
7 Zinc	6.42E-01	NA	0.00E+00	
				2.12E-03

REPRESENTATIVE NONCARCINOGENIC RISKS TO A
CHILD FROM EAST HELENA
TABLES B-127 THROUGH B-133

TABLE B-127. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE CHILD IN EAST HELENA

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.63E-04	9.50E-04	1.47E-02	
2 Cadmium	1.51E-06	5.00E-05	2.59E-03	
3 Copper	8.48E-04	2.20E-02	3.30E-03	
4 Iron	NA	ND	0.00E+00	
5 Lead	4.56E-04	ND	0.00E+00	
6 Manganese	8.68E-05	8.00E-03	9.30E-04	
7 Zinc	9.10E-04	6.00E-02	1.30E-03	
				2.28E-02

TABLE B-128. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.22E-06	ND	0.00E+00	
2 Cadmium	3.35E-06	ND	0.00E+00	
3 Copper	5.45E-05	ND	0.00E+00	
4 Iron	1.65E-05	ND	0.00E+00	
5 Lead	3.23E-05	ND	0.00E+00	
6 Manganese	5.38E-07	1.40E-04	3.29E-04	
7 Zinc	1.50E-05	ND	0.00E+00	
				3.29E-04

TABLE 8-129. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.81E-07	ND	0.00E+00	
2 Cadmium	1.31E-07	ND	0.00E+00	
3 Copper	1.84E-06	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	5.33E-06	ND	0.00E+00	
6 Manganese	2.53E-06	1.40E-04	1.55E-03	
7 Zinc	3.15E-06	ND	0.00E+00	
				1.55E-03

TABLE B-130. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE CHILD IN EAST HELENA

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.21E-03	9.50E-04	1.99E-01	
2 Cadmium	1.33E-04	5.00E-05	2.28E-01	
3 Copper	1.34E-02	2.20E-02	5.22E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.74E-03	ND	0.00E+00	
6 Manganese	4.86E-03	8.00E-03	5.21E-02	
7 Zinc	5.35E-02	6.00E-02	7.64E-02	
				6.08E-01

TABLE B-131. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.07E-05	9.50E-04	9.65E-04	
2 Cadmium	4.66E-06	5.00E-05	7.99E-03	
3 Copper	6.52E-05	2.20E-02	2.54E-04	
4 Iron	NA	ND	0.00E+00	
5 Lead	2.11E-04	ND	0.00E+00	
6 Manganese	1.00E-04	8.00E-03	1.07E-03	
7 Zinc	1.12E-04	6.00E-02	1.60E-04	
				1.04E-02

TABLE B-132. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	8.99E-06	9.50E-04	8.11E-04	
2 Cadmium	1.50E-07	5.00E-05	2.57E-04	
3 Copper	9.76E-05	2.20E-02	3.80E-04	
4 Iron	8.53E-06	ND	0.00E+00	
5 Lead	1.16E-05	ND	0.00E+00	
6 Manganese	1.97E-07	8.00E-03	2.11E-06	
7 Zinc	1.78E-05	6.00E-02	2.54E-05	
				1.48E-03

TABLE B-133. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE CHILD IN EAST HELENA

	CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
	1 Arsenic	2.16E-01	0.00E+00	2.16E-01
	2 Cadmium	2.39E-01	0.00E+00	2.39E-01
	3 Copper	5.61E-02	0.00E+00	5.61E-02
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	5.41E-02	1.88E-03	5.60E-02
	7 Zinc	7.79E-02	0.00E+00	7.79E-02
TOTAL		6.43E-01	1.88E-03	6.45E-01

WORST CASE NONCARCINOGENIC RISKS TO A
CHILD FROM EAST HELENA
TABLES B-134 THROUGH B-143

TABLE B-134. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	6.00E-04	9.50E-04	5.41E-02	
2 Cadmium	6.60E-06	5.00E-05	1.13E-02	
3 Copper	1.46E-02	2.20E-02	5.69E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	2.84E-03	ND	0.00E+00	
6 Manganese	1.85E-04	8.00E-03	1.98E-03	
7 Zinc	7.66E-03	6.00E-02	1.09E-02	
				1.35E-01

TABLE B-135. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.45E-06	ND	0.00E+00	
2 Cadmium	6.69E-06	ND	0.00E+00	
3 Copper	1.09E-04	ND	0.00E+00	
4 Iron	3.30E-05	ND	0.00E+00	
5 Lead	6.47E-05	ND	0.00E+00	
6 Manganese	1.05E-06	1.40E-04	6.43E-04	
7 Zinc	3.01E-05	ND	0.00E+00	
				6.43E-04

TABLE B-136. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	6.91E-07	ND	0.00E+00	
2 Cadmium	5.92E-07	ND	0.00E+00	
3 Copper	3.28E-05	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	3.44E-05	ND	0.00E+00	
6 Manganese	5.59E-06	1.40E-04	3.42E-03	
7 Zinc	2.75E-05	ND	0.00E+00	
				3.42E-03

TABLE B-137. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.22E-03	9.50E-04	3.81E-01	
2 Cadmium	2.79E-04	5.00E-05	4.78E-01	
3 Copper	1.97E-02	2.20E-02	7.68E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	4.94E-03	ND	0.00E+00	
6 Manganese	7.19E-03	8.00E-03	7.70E-02	
7 Zinc	1.04E-01	6.00E-02	1.49E-01	
				1.16E+00

TABLE B-138. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.09E-05	9.50E-04	3.69E-03	
2 Cadmium	2.10E-05	5.00E-05	3.60E-02	
3 Copper	1.16E-03	2.20E-02	4.52E-03	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.36E-03	ND	0.00E+00	
6 Manganese	2.21E-04	8.00E-03	2.37E-03	
7 Zinc	9.76E-04	6.00E-02	1.39E-03	
				4.80E-02

TABLE B-139. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.85E-05	9.50E-04	1.67E-03	
2 Cadmium	3.05E-07	5.00E-05	5.23E-04	
3 Copper	2.13E-04	2.20E-02	8.30E-04	
4 Iron	1.70E-05	ND	0.00E+00	
5 Lead	2.62E-05	ND	0.00E+00	
6 Manganese	4.16E-07	8.00E-03	4.46E-06	
7 Zinc	4.36E-05	6.00E-02	6.23E-05	
				3.09E-03

TABLE B-140. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	6.27E-04	9.50E-04	5.66E-02	
2 Cadmium	3.84E-04	5.00E-05	6.58E-01	
3 Copper	NA	2.20E-02	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	9.97E-03	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	1.21E+00	6.00E-02	1.73E+00	
				2.44E+00

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TABLE B-141. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE CHILD IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.16E-01	9.50E-04	1.05E+01	
2 Cadmium	1.00E-03	5.00E-05	1.71E+00	
3 Copper	1.29E-03	2.20E-02	5.03E-03	
4 Iron	4.43E-02	ND	0.00E+00	
5 Lead	1.86E-03	ND	0.00E+00	
6 Manganese	3.07E+00	8.00E-03	3.29E+01	
7 Zinc	1.79E-02	6.00E-02	2.56E-02	
				4.51E+01

TABLE B-142. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE CHILD IN EAST HELENA

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.12E-03	9.50E-04	3.72E-01	
2 Cadmium	3.04E-04	5.00E-05	5.21E-01	
3 Copper	4.05E-02	2.20E-02	1.58E-01	
4 Iron	NA	ND	0.00E+00	
5 Lead	2.12E-03	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	2.24E-01	6.00E-02	3.20E-01	
				1.37E+00

TABLE B-143. CHEMICAL-SPECIFIC RISK FOR WORST CASE CHILD IN EAST HELENA.

	CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
	1 Arsenic	1.13E+01	0.00E+00	1.13E+01
	2 Cadmium	3.42E+00	0.00E+00	3.42E+00
	3 Copper	3.02E-01	0.00E+00	3.02E-01
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	3.30E+01	4.07E-03	3.30E+01
	7 Zinc	2.24E+00	0.00E+00	2.24E+00
TOTAL		5.03E+01	4.07E-03	5.03E+01

REPRESENTATIVE NONCARCINOGENIC RISKS TO
A CHILD FROM MANLOVE
TABLES B-144 THROUGH TABLES B-153

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TABLE B-144. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.60E-04	9.50E-04	1.44E-02	
2 Cadmium	1.49E-06	5.00E-05	2.55E-03	
3 Copper	8.32E-04	2.20E-02	3.24E-03	
4 Iron	NA	ND	0.00E+00	
5 Lead	4.48E-04	ND	0.00E+00	
6 Manganese	8.51E-05	8.00E-03	9.12E-04	
7 Zinc	8.92E-04	6.00E-02	1.27E-03	
				2.24E-02

TABLE B-145. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.22E-06	ND	0.00E+00	
2 Cadmium	3.35E-06	ND	0.00E+00	
3 Copper	5.45E-05	ND	0.00E+00	
4 Iron	1.65E-05	ND	0.00E+00	
5 Lead	3.23E-05	ND	0.00E+00	
6 Manganese	5.38E-07	1.40E-04	3.29E-04	
7 Zinc	1.50E-05	ND	0.00E+00	
				3.29E-04

TABLE B-146. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.81E-07	ND	0.00E+00	
2 Cadmium	1.31E-07	ND	0.00E+00	
3 Copper	1.84E-06	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	5.33E-06	ND	0.00E+00	
6 Manganese	2.53E-06	1.40E-04	1.55E-03	
7 Zinc	3.15E-06	ND	0.00E+00	
				1.55E-03

TABLE B-147. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR REPRESENTATIVE CHILD IN WANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.58E-05	9.50E-04	4.13E-03	
2 Cadmium	1.97E-07	5.00E-05	3.38E-04	
3 Copper	2.69E-06	2.20E-02	1.05E-05	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	3.36E-05	ND	0.00E+00	
6 Manganese	7.43E-06	8.00E-03	7.96E-05	
7 Zinc	8.85E-05	6.00E-02	1.26E-04	
				4.69E-03

TABLE 148. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	8.26E-05	9.50E-04	7.45E-03	
2 Cadmium	1.66E-05	5.00E-05	2.85E-02	
3 Copper	5.67E-05	2.20E-02	2.21E-04	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	4.25E-04	ND	0.00E+00	
6 Manganese	2.35E-04	8.00E-03	2.52E-03	
7 Zinc	2.98E-04	6.00E-02	4.26E-04	
				3.91E-02

TABLE B-149. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.21E-03	9.50E-04	1.99E-01	
2 Cadmium	1.33E-04	5.00E-05	2.28E-01	
3 Copper	1.34E-02	2.20E-02	5.22E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.74E-03	ND	0.00E+00	
6 Manganese	4.86E-03	8.00E-03	5.21E-02	
7 Zinc	5.35E-02	6.00E-02	7.64E-02	
				6.08E-01

TABLE B-150. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.07E-05	9.50E-04	9.65E-04	
2 Cadmium	4.66E-06	5.00E-05	7.99E-03	
3 Copper	6.52E-05	2.20E-02	2.54E-04	
4 Iron	NA	ND	0.00E+00	
5 Lead	2.11E-04	ND	0.00E+00	
6 Manganese	1.00E-04	8.00E-03	1.07E-03	
7 Zinc	1.12E-04	6.00E-02	1.60E-04	
				1.04E-02

TABLE B-151. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	8.99E-06	9.50E-04	8.11E-04	
2 Cadmium	1.50E-07	5.00E-05	2.57E-04	
3 Copper	9.76E-05	2.20E-02	3.80E-04	
4 Iron	8.53E-06	ND	0.00E+00	
5 Lead	1.16E-05	ND	0.00E+00	
6 Manganese	1.97E-07	8.00E-03	2.11E-06	
7 Zinc	1.78E-05	6.00E-02	2.54E-05	
				1.48E-03

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WORST CASE NONCARCINOGENIC RISKS TO A CHILD FROM MANLOVE
TABLES B-154 THROUGH B-166

TABLE B-154. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	6.09E-04	9.50E-04	5.49E-02	
2 Cadmium	6.71E-06	5.00E-05	1.15E-02	
3 Copper	1.49E-02	2.20E-02	5.81E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	2.88E-03	ND	0.00E+00	
6 Manganese	1.88E-04	8.00E-03	2.01E-03	
7 Zinc	7.79E-03	6.00E-02	1.11E-02	
				1.38E-01

TABLE B-155. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.45E-06	ND	0.00E+00	
2 Cadmium	6.69E-06	ND	0.00E+00	
3 Copper	1.09E-04	ND	0.00E+00	
4 Iron	3.30E-05	ND	0.00E+00	
5 Lead	6.47E-05	ND	0.00E+00	
6 Manganese	1.05E-06	1.40E-04	6.43E-04	
7 Zinc	3.01E-05	ND	0.00E+00	
				6.43E-04

TABLE B-156. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	6.91E-07	ND	0.00E+00	
2 Cadmium	5.92E-07	ND	0.00E+00	
3 Copper	3.28E-05	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	3.44E-05	ND	0.00E+00	
6 Manganese	5.59E-06	1.40E-04	3.42E-03	
7 Zinc	2.75E-05	ND	0.00E+00	
				3.42E-03

TABLE B-157. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.14E-04	9.50E-04	1.03E-02	
2 Cadmium	2.96E-07	5.00E-05	5.07E-04	
3 Copper	4.05E-06	2.20E-02	1.58E-05	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	5.13E-06	ND	0.00E+00	
6 Manganese	8.63E-06	8.00E-03	9.25E-05	
7 Zinc	1.43E-04	6.00E-02	2.04E-04	
				1.11E-02

TABLE B-158. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.07E-04	9.50E-04	1.87E-02	
2 Cadmium	2.49E-05	5.00E-05	4.27E-02	
3 Copper	8.44E-05	2.20E-02	3.29E-04	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	6.48E-04	ND	0.00E+00	
6 Manganese	2.73E-04	8.00E-03	2.93E-03	
7 Zinc	4.83E-04	6.00E-02	6.90E-04	
				6.53E-02

TABLE B-159. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.22E-03	9.50E-04	3.81E-01	
2 Cadmium	2.79E-04	5.00E-05	4.78E-01	
3 Copper	1.97E-02	2.20E-02	7.68E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	4.94E-03	ND	0.00E+00	
6 Manganese	7.19E-03	8.00E-03	7.70E-02	
7 Zinc	1.04E-01	6.00E-02	1.49E-01	
				1.16E+00

TABLE B-160. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.09E-05	9.50E-04	3.69E-03	
2 Cadmium	2.10E-05	5.00E-05	3.60E-02	
3 Copper	1.16E-03	2.20E-02	4.52E-03	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.36E-03	ND	0.00E+00	
6 Manganese	2.21E-04	8.00E-03	2.37E-03	
7 Zinc	9.76E-04	6.00E-02	1.39E-03	
				4.80E-02

TABLE B-161. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.85E-05	9.50E-04	1.67E-03	
2 Cadmium	3.05E-07	5.00E-05	5.23E-04	
3 Copper	2.13E-04	2.20E-02	8.30E-04	
4 Iron	1.70E-05	ND	0.00E+00	
5 Lead	2.62E-05	ND	0.00E+00	
6 Manganese	4.16E-07	8.00E-03	4.46E-06	
7 Zinc	4.36E-05	6.00E-02	6.23E-05	
				3.09E-03

TABLE B-162. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	8.14E-09	9.50E-04	7.34E-07	
2 Cadmium	1.63E-09	5.00E-05	2.79E-06	
3 Copper	5.43E-09	2.20E-02	2.12E-08	
4 Iron	3.39E-08	ND	0.00E+00	
5 Lead	6.78E-09	ND	0.00E+00	
6 Manganese	4.86E-08	8.00E-03	5.21E-07	
7 Zinc	2.82E-08	6.00E-02	4.03E-08	
				4.11E-06

TABLE B-163. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	6.27E-04	9.50E-04	5.66E-02	
2 Cadmium	3.84E-05	5.00E-05	6.58E-02	
3 Copper	NA	2.20E-02	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	9.97E-03	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	1.21E+00	6.00E-02	1.73E+00	
				1.85E+00

TABLE B-164. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.16E-01	9.50E-04	1.05E+01	
2 Cadmium	1.00E-03	5.00E-05	1.71E+00	
3 Copper	1.29E-03	2.20E-02	5.03E-03	
4 Iron	4.43E-02	ND	0.00E+00	
5 Lead	1.86E-03	ND	0.00E+00	
6 Manganese	3.07E+00	8.00E-03	3.29E+01	
7 Zinc	1.79E-02	6.00E-02	2.56E-02	
				4.51E+01

TABLE B-165. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.12E-03	9.50E-04	3.72E-01	
2 Cadmium	3.04E-04	5.00E-05	5.21E-01	
3 Copper	4.05E-02	2.20E-02	1.58E-01	
4 Iron	NA	ND	0.00E+00	
5 Lead	2.12E-03	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	2.24E-01	6.00E-02	3.20E-01	
				1.37E+00

TABLE B-166. CHEMICAL-SPECIFIC RISK FOR WORST CASE CHILD IN MANLOVE.

CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
1 Arsenic	1.14E+01	0.00E+00	1.14E+01
2 Cadmium	2.87E+00	0.00E+00	2.87E+00
3 Copper	3.03E-01	0.00E+00	3.03E-01
4 Iron	0.00E+00	0.00E+00	0.00E+00
5 Lead	0.00E+00	0.00E+00	0.00E+00
6 Manganese	3.30E+01	4.07E-03	3.30E+01
7 Zinc	2.24E+00	0.00E+00	2.24E+00
TOTAL	4.98E+01	4.07E-03	4.98E+01

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REPRESENTATIVE NONCARCINOGENIC RISKS TO A YOUTH FROM EAST HELENA TALBES B-167 THROUGH B-176

TABLE B-167. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	5.08E-05	9.50E-04	4.58E-03	
2 Cadmium	4.73E-07	5.00E-05	8.11E-04	
3 Copper	2.65E-04	2.20E-02	1.03E-03	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.43E-04	ND	0.00E+00	
6 Manganese	2.71E-05	8.00E-03	2.90E-04	
7 Zinc	2.84E-04	6.00E-02	4.06E-04	
				7.12E-03

TABLE B-168. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.01E-06	ND	0.00E+00	
2 Cadmium	1.51E-06	ND	0.00E+00	
3 Copper	2.47E-05	ND	0.00E+00	
4 Iron	7.47E-06	ND	0.00E+00	
5 Lead	1.46E-05	ND	0.00E+00	
6 Manganese	2.43E-07	1.40E-04	1.49E-04	
7 Zinc	6.79E-06	ND	0.00E+00	
				1.49E-04

TABLE B-169. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	7.91E-08	ND	0.00E+00	
2 Cadmium	5.72E-08	ND	0.00E+00	
3 Copper	8.01E-07	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	2.33E-06	ND	0.00E+00	
6 Manganese	1.11E-06	1.40E-04	6.80E-04	
7 Zinc	1.37E-06	ND	0.00E+00	
				6.80E-04

TABLE B-170. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.97E-03	9.50E-04	1.78E-01	
2 Cadmium	1.17E-04	5.00E-05	2.01E-01	
3 Copper	1.22E-02	2.20E-02	4.75E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.53E-03	ND	0.00E+00	
6 Manganese	4.27E-03	8.00E-03	4.58E-02	
7 Zinc	4.75E-02	6.00E-02	6.79E-02	
				5.39E-01

TABLE B-171. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	5.83E-06	9.50E-04	5.26E-04	
2 Cadmium	2.53E-06	5.00E-05	4.34E-03	
3 Copper	3.55E-05	2.20E-02	1.38E-04	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.14E-04	ND	0.00E+00	
6 Manganese	5.44E-05	8.00E-03	5.83E-04	
7 Zinc	6.08E-05	6.00E-02	8.69E-05	
				5.67E-03

TABLE B-172. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.06E-06	9.50E-04	3.66E-04	
2 Cadmium	6.79E-08	5.00E-05	1.16E-04	
3 Copper	4.42E-05	2.20E-02	1.72E-04	
4 Iron	3.86E-06	ND	0.00E+00	
5 Lead	5.24E-06	ND	0.00E+00	
6 Manganese	8.71E-08	8.00E-03	9.33E-07	
7 Zinc	8.04E-06	6.00E-02	1.15E-05	
				6.67E-04

TABLE B-173. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.25E-07	9.50E-04	2.03E-05	
2 Cadmium	1.02E-09	5.00E-05	1.75E-06	
3 Copper	5.53E-07	2.20E-02	2.15E-06	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	3.99E-07	ND	0.00E+00	
6 Manganese	6.01E-07	8.00E-03	6.44E-06	
7 Zinc	3.45E-06	6.00E-02	4.93E-06	
				3.56E-05

TABLE B-174. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	5.87E-07	9.50E-04	5.30E-05	
2 Cadmium	1.24E-07	5.00E-05	2.13E-04	
3 Copper	1.68E-06	2.20E-02	6.55E-06	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	7.28E-06	ND	0.00E+00	
6 Manganese	2.74E-05	8.00E-03	2.94E-04	
7 Zinc	1.68E-05	6.00E-02	2.40E-05	
				5.90E-04

TABLE B-175. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR REPRESENTATIVE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
Arsenic	5.03E-10	9.50E-04	4.54E-08	
Cadmium	1.57E-10	5.00E-05	2.69E-07	
Copper	2.20E-10	2.20E-02	8.57E-10	
Iron	2.11E-09	ND	0.00E+00	
Lead	1.89E-10	ND	0.00E+00	
Manganese	2.26E-09	8.00E-03	2.42E-08	
Zinc	1.13E-09	6.00E-02	1.61E-09	
				3.41E-07

TABLE B-176. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE YOUTH IN EAST HELENA.

	CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
	1 Arsenic	1.83E-01	0.00E+00	1.83E-01
	2 Cadmium	2.06E-01	0.00E+00	2.06E-01
	3 Copper	4.89E-02	0.00E+00	4.89E-02
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	4.69E-02	8.28E-04	4.78E-02
	7 Zinc	6.84E-02	0.00E+00	6.84E-02
TOTAL		5.54E-01	8.28E-04	5.54E-01

WORST CASE NONCARCINOGENIC RISKS TO A
YOUTH FROM EAST HELENA
TABLES B-177 THROUGH B-189

TABLE B-177. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.94E-04	9.50E-04	1.75E-02	
2 Cadmium	2.14E-06	5.00E-05	3.67E-03	
3 Copper	4.73E-03	2.20E-02	1.84E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	9.19E-04	ND	0.00E+00	
6 Manganese	5.98E-05	8.00E-03	6.41E-04	
7 Zinc	2.48E-03	6.00E-02	3.54E-03	
				4.38E-02

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TABLE B-17B. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.01E-06	ND	0.00E+00	
2 Cadmium	3.03E-06	ND	0.00E+00	
3 Copper	4.94E-05	ND	0.00E+00	
4 Iron	1.49E-05	ND	0.00E+00	
5 Lead	2.93E-05	ND	0.00E+00	
6 Manganese	4.77E-07	1.40E-04	2.92E-04	
7 Zinc	1.36E-05	ND	0.00E+00	
				2.92E-04

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TABLE B-179. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	3.02E-07	ND	0.00E+00	
2 Cadmium	2.58E-07	ND	0.00E+00	
3 Copper	1.43E-05	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.50E-05	ND	0.00E+00	
6 Manganese	2.44E-06	1.40E-04	1.49E-03	
7 Zinc	1.20E-05	ND	0.00E+00	
				1.49E-03

TABLE B-180. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	3.79E-03	9.50E-04	3.42E-01	
2 Cadmium	2.47E-04	5.00E-05	4.23E-01	
3 Copper	1.82E-02	2.20E-02	7.09E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	4.37E-03	ND	0.00E+00	
6 Manganese	6.38E-03	8.00E-03	6.84E-02	
7 Zinc	9.32E-02	6.00E-02	1.33E-01	
				1.04E+00

TABLE B-181. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE YOUTH IN EAST HELENA

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.23E-05	9.50E-04	2.01E-03	
2 Cadmium	1.14E-05	5.00E-05	1.95E-02	
3 Copper	6.33E-04	2.20E-02	2.47E-03	
4 Iron	NA	ND	0.00E+00	
5 Lead	7.38E-04	ND	0.00E+00	
6 Manganese	1.20E-04	8.00E-03	1.29E-03	
7 Zinc	5.31E-04	6.00E-02	7.59E-04	
				2.61E-02

TABLE B-182. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	8.36E-06	9.50E-04	7.54E-04	
2 Cadmium	1.38E-07	5.00E-05	2.37E-04	
3 Copper	9.62E-05	2.20E-02	3.75E-04	
4 Iron	7.71E-06	ND	0.00E+00	
5 Lead	1.18E-05	ND	0.00E+00	
6 Manganese	1.84E-07	8.00E-03	1.97E-06	
7 Zinc	1.96E-05	6.00E-02	2.80E-05	
				1.40E-03

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TABLE B-183. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR WORST CASE YOUTH IN EAST HELENA

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	6.03E-07	9.50E-04	5.44E-05	
2 Cadmium	2.92E-09	5.00E-05	5.01E-06	
3 Copper	1.28E-06	2.20E-02	4.99E-06	
4 Iron	1.26E-04	ND	0.00E+00	
5 Lead	1.49E-06	ND	0.00E+00	
6 Manganese	1.17E-06	8.00E-03	1.25E-05	
7 Zinc	1.02E-05	6.00E-02	1.46E-05	
				9.15E-05

TABLE B-184. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.57E-06	9.50E-04	1.42E-04	
2 Cadmium	3.56E-07	5.00E-05	6.10E-04	
3 Copper	3.65E-06	2.20E-02	1.42E-05	
4 Iron	6.55E-04	ND	0.00E+00	
5 Lead	2.71E-05	ND	0.00E+00	
6 Manganese	5.33E-05	8.00E-03	5.71E-04	
7 Zinc	4.96E-05	6.00E-02	7.09E-05	
				1.41E-03

TABLE B-185. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
Arsenic	2.48E-09	9.50E-04	2.24E-07	
Cadmium	3.46E-10	5.00E-05	5.93E-07	
Copper	2.83E-10	2.20E-02	1.10E-09	
Iron	4.09E-09	ND	0.00E+00	
Lead	6.29E-09	ND	0.00E+00	
Manganese	8.77E-09	8.00E-03	9.40E-08	
Zinc	2.58E-09	6.00E-02	3.69E-09	
				9.16E-07

TABLE B-186. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.25E-04	9.50E-04	2.03E-02	
2 Cadmium	1.38E-05	5.00E-05	2.37E-02	
3 Copper	NA	2.20E-02	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	3.58E-03	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	4.33E-01	6.00E-02	6.19E-01	
				6.63E-01

TABLE B-187. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.18E-02	9.50E-04	3.77E+00	
2 Cadmium	3.59E-04	5.00E-05	6.15E-01	
3 Copper	4.62E-04	2.20E-02	1.80E-03	
4 Iron	1.59E-02	ND	0.00E+00	
5 Lead	6.67E-04	ND	0.00E+00	
6 Manganese	1.10E+00	8.00E-03	1.18E+01	
7 Zinc	6.41E-03	6.00E-02	9.16E-03	1.62E+01

TABLE B-188. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.48E-03	9.50E-04	1.34E-01	
2 Cadmium	1.09E-04	5.00E-05	1.87E-01	
3 Copper	1.45E-02	2.20E-02	5.65E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	7.62E-04	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	8.05E-02	6.00E-02	1.15E-01	
				4.92E-01

TABLE B-189. CHEMICAL-SPECIFIC RISK FOR WORST CASE YOUTH IN EAST HELENA.

CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
1 Arsenic	4.29E+00	0.00E+00	4.29E+00
2 Cadmium	1.27E+00	0.00E+00	1.27E+00
3 Copper	1.50E-01	0.00E+00	1.50E-01
4 Iron	0.00E+00	0.00E+00	0.00E+00
5 Lead	0.00E+00	0.00E+00	0.00E+00
6 Manganese	1.19E+01	1.79E-03	1.19E+01
7 Zinc	8.80E-01	0.00E+00	8.80E-01
TOTAL	1.84E+01	1.79E-03	1.85E+01

REPRESENTATIVE NONCARCINOGENIC RISKS TO
A YOUTH FROM MANLOVE
TABLES B-190 THROUGH B-199

TABLE B-190. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.92E-05	9.50E-04	4.44E-03	
2 Cadmium	4.58E-07	5.00E-05	7.85E-04	
3 Copper	2.56E-04	2.20E-02	9.97E-04	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.38E-04	ND	0.00E+00	
6 Manganese	2.62E-05	8.00E-03	2.81E-04	
7 Zinc	2.75E-04	6.00E-02	3.93E-04	
				6.90E-03

TABLE B-191. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.01E-06	ND	0.00E+00	
2 Cadmium	1.51E-06	ND	0.00E+00	
3 Copper	2.47E-05	ND	0.00E+00	
4 Iron	7.47E-06	ND	0.00E+00	
5 Lead	1.46E-05	ND	0.00E+00	
6 Manganese	2.43E-07	1.40E-04	1.49E-04	
7 Zinc	6.79E-06	ND	0.00E+00	
				1.49E-04

TABLE B-192. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE YOUTH IN MANLOVE.

	CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1	Arsenic	7.91E-08	ND	0.00E+00	
2	Cadmium	5.72E-08	ND	0.00E+00	
3	Copper	8.01E-07	ND	0.00E+00	
4	Iron	NA	ND	0.00E+00	
5	Lead	2.33E-06	ND	0.00E+00	
6	Manganese	1.11E-06	1.40E-04	6.80E-04	
7	Zinc	1.37E-06	ND	0.00E+00	
					6.80E-04

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TABLE B-193. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.99E-05	9.50E-04	2.70E-03	
2 Cadmium	1.28E-07	5.00E-05	2.19E-04	
3 Copper	1.76E-05	2.20E-02	6.86E-05	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	2.19E-05	ND	0.00E+00	
6 Manganese	4.85E-06	8.00E-03	5.20E-05	
7 Zinc	5.78E-05	6.00E-02	8.26E-05	
				3.12E-03

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TABLE B-194. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.56E-05	9.50E-04	1.41E-03	
2 Cadmium	3.13E-06	5.00E-05	5.37E-03	
3 Copper	1.07E-05	2.20E-02	4.17E-05	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	8.00E-05	ND	0.00E+00	
6 Manganese	4.42E-05	8.00E-03	4.74E-04	
7 Zinc	5.62E-05	6.00E-02	8.03E-05	
				7.37E-03

TABLE B-195. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.97E-03	9.50E-04	1.78E-01	
2 Cadmium	1.17E-04	5.00E-05	2.01E-01	
3 Copper	1.22E-02	2.20E-02	4.75E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.53E-03	ND	0.00E+00	
6 Manganese	4.27E-03	8.00E-03	4.58E-02	
7 Zinc	4.75E-02	6.00E-02	6.79E-02	
				5.39E-01

TABLE B-196. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	5.83E-06	9.50E-04	5.26E-04	
2 Cadmium	2.53E-06	5.00E-05	4.34E-03	
3 Copper	3.55E-05	2.20E-02	1.38E-04	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.14E-04	ND	0.00E+00	
6 Manganese	5.44E-05	8.00E-03	5.83E-04	
7 Zinc	6.08E-05	6.00E-02	8.69E-05	
				5.67E-03

TABLE B-197. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.06E-06	9.50E-04	3.66E-04	
2 Cadmium	6.79E-08	5.00E-05	1.16E-04	
3 Copper	4.42E-05	2.20E-02	1.72E-04	
4 Iron	3.86E-06	ND	0.00E+00	
5 Lead	5.24E-06	ND	0.00E+00	
6 Manganese	8.71E-08	8.00E-03	9.33E-07	
7 Zinc	8.04E-06	6.00E-02	1.15E-05	
				6.67E-04

TABLE B-198. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR REPRESENTATIVE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
Arsenic	1.32E-09	9.50E-04	1.19E-07	
Cadmium	1.76E-10	5.00E-05	3.02E-07	
Copper	8.78E-10	2.20E-02	3.42E-09	
Iron	8.34E-09	ND	0.00E+00	
Lead	8.56E-10	ND	0.00E+00	
Manganese	1.50E-08	8.00E-03	1.61E-07	
Zinc	3.18E-09	6.00E-02	4.54E-09	
				5.89E-07

TABLE B-199. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE YOUTH IN MANLOVE.

	CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
	1 Arsenic	1.87E-01	0.00E+00	1.87E-01
	2 Cadmium	2.11E-01	0.00E+00	2.11E-01
	3 Copper	4.90E-02	0.00E+00	4.90E-02
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	4.71E-02	8.28E-04	4.80E-02
	7 Zinc	6.85E-02	0.00E+00	6.85E-02
TOTAL		5.63E-01	8.28E-04	5.64E-01

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WORST CASE NONCARCINOGENIC RISKS TO
A YOUTH FROM MANLOVE
TABLES B-200 THROUGH B-212

TABLE B-200. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.88E-04	9.50E-04	1.70E-02	
2 Cadmium	2.07E-06	5.00E-05	3.55E-03	
3 Copper	4.58E-03	2.20E-02	1.78E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	8.89E-04	ND	0.00E+00	
6 Manganese	5.78E-05	8.00E-03	6.19E-04	
7 Zinc	2.40E-03	6.00E-02	3.43E-03	
				4.24E-02

TABLE B-201. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.01E-06	ND	0.00E+00	
2 Cadmium	3.03E-06	ND	0.00E+00	
3 Copper	4.94E-05	ND	0.00E+00	
4 Iron	1.49E-05	ND	0.00E+00	
5 Lead	2.93E-05	ND	0.00E+00	
6 Manganese	4.77E-07	1.40E-04	2.92E-04	
7 Zinc	1.36E-05	ND	0.00E+00	
				2.92E-04

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TABLE B-202. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	3.02E-07	ND	0.00E+00	
2 Cadmium	2.58E-07	ND	0.00E+00	
3 Copper	1.43E-05	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.50E-05	ND	0.00E+00	
6 Manganese	2.44E-06	1.40E-04	1.49E-03	
7 Zinc	1.20E-05	ND	0.00E+00	
				1.49E-03

TABLE B-203. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	7.47E-05	9.50E-04	6.74E-03	
2 Cadmium	1.93E-07	5.00E-05	3.31E-04	
3 Copper	2.62E-05	2.20E-02	1.02E-04	
4 Iron	4.23E-04	ND	0.00E+00	
5 Lead	3.35E-05	ND	0.00E+00	
6 Manganese	5.63E-06	8.00E-03	6.03E-05	
7 Zinc	9.36E-05	6.00E-02	1.34E-04	
				7.37E-03

TABLE B-204. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	3.89E-05	9.50E-04	3.51E-03	
2 Cadmium	4.70E-06	5.00E-05	8.06E-03	
3 Copper	1.59E-05	2.20E-02	6.19E-05	
4 Iron	4.41E-04	ND	0.00E+00	
5 Lead	1.22E-04	ND	0.00E+00	
6 Manganese	5.14E-05	8.00E-03	5.51E-04	
7 Zinc	9.10E-05	6.00E-02	1.30E-04	
				1.23E-02

TABLE B-205. PATHWAY-SPECIFIC RISK--VEGATABLE CONSUMPTION FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	3.79E-03	9.50E-04	3.42E-01	
2 Cadmium	2.47E-04	5.00E-05	4.23E-01	
3 Copper	1.82E-02	2.20E-02	7.09E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	4.37E-03	ND	0.00E+00	
6 Manganese	6.38E-03	8.00E-03	6.84E-02	
7 Zinc	9.32E-02	6.00E-02	1.33E-01	
				1.04E+00

TABLE B-206. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.23E-05	9.50E-04	2.01E-03	
2 Cadmium	1.14E-05	5.00E-05	1.95E-02	
3 Copper	6.33E-04	2.20E-02	2.47E-03	
4 Iron	NA	ND	0.00E+00	
5 Lead	7.38E-04	ND	0.00E+00	
6 Manganese	1.20E-04	8.00E-03	1.29E-03	
7 Zinc	5.31E-04	6.00E-02	7.59E-04	
				2.61E-02

TABLE B-207. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	8.36E-06	9.50E-04	7.54E-04	
2 Cadmium	1.38E-07	5.00E-05	2.37E-04	
3 Copper	9.62E-05	2.20E-02	3.75E-04	
4 Iron	7.71E-06	ND	0.00E+00	
5 Lead	1.18E-05	ND	0.00E+00	
6 Manganese	1.84E-07	8.00E-03	1.97E-06	
7 Zinc	1.96E-05	6.00E-02	2.80E-05	
				1.40E-03

TABLE B-208. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	3.29E-09	9.50E-04	2.97E-07	
2 Cadmium	6.59E-10	5.00E-05	1.13E-06	
3 Copper	2.20E-09	2.20E-02	8.57E-09	
4 Iron	1.37E-08	ND	0.00E+00	
5 Lead	2.74E-09	ND	0.00E+00	
6 Manganese	1.97E-08	8.00E-03	2.11E-07	
7 Zinc	1.14E-08	6.00E-02	1.63E-08	
				1.66E-06

TABLE B-209. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.25E-04	9.50E-04	2.03E-02	
2 Cadmium	1.38E-05	5.00E-05	2.37E-02	
3 Copper	NA	2.20E-02	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	3.58E-03	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	4.33E-01	6.00E-02	6.19E-01	
				6.63E-01

TABLE B-210. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.18E-02	9.50E-04	3.77E+00	
2 Cadmium	3.59E-04	5.00E-05	6.15E-01	
3 Copper	4.62E-04	2.20E-02	1.80E-03	
4 Iron	1.59E-02	ND	0.00E+00	
5 Lead	6.67E-04	ND	0.00E+00	
6 Manganese	1.10E+00	8.00E-03	1.18E+01	
7 Zinc	6.41E-03	6.00E-02	9.16E-03	
				1.62E+01

TABLE B-211. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.48E-03	9.50E-04	1.34E-01	
2 Cadmium	1.09E-04	5.00E-05	1.87E-01	
3 Copper	1.45E-02	2.20E-02	5.65E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	7.62E-04	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	8.05E-02	6.00E-02	1.15E-01	
				4.92E-01

TABLE B-212. CHEMICAL-SPECIFIC RISK FOR WORST CASE YOUTH IN MANLOVE.

CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
1 Arsenic	4.30E+00	0.00E+00	4.30E+00
2 Cadmium	1.28E+00	0.00E+00	1.28E+00
3 Copper	1.50E-01	0.00E+00	1.50E-01
4 Iron	0.00E+00	0.00E+00	0.00E+00
5 Lead	0.00E+00	0.00E+00	0.00E+00
6 Manganese	1.19E+01	1.79E-03	1.19E+01
7 Zinc	8.80E-01	0.00E+00	8.80E-01
TOTAL	1.85E+01	1.79E-03	1.85E+01

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REPRESENTATIVE NONCARCINOGENIC RISKS TO
AN ADULT
TABLES B-213 THROUGH B-219

TABLE B-213. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE ADULT

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	5.03E-07	ND	0.00E+00	
2 Cadmium	7.56E-07	ND	0.00E+00	
3 Copper	1.23E-05	ND	0.00E+00	
4 Iron	3.73E-06	ND	0.00E+00	
5 Lead	7.29E-06	ND	0.00E+00	
6 Manganese	1.22E-07	1.40E-04	7.22E-04	
7 Zinc	3.39E-06	ND	0.00E+00	
				7.22E-04

TABLE B-214. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE ADULT.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.18E-07	ND	0.00E+00	
2 Cadmium	1.58E-07	ND	0.00E+00	
3 Copper	2.21E-06	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	6.41E-06	ND	0.00E+00	
6 Manganese	3.05E-06	1.40E-04	1.81E-02	
7 Zinc	3.79E-06	ND	0.00E+00	
				1.81E-02

TABLE B-215. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE ADULT.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.86E-05	9.50E-04	2.49E-02	
2 Cadmium	2.66E-07	5.00E-05	4.41E-03	
3 Copper	1.49E-04	2.20E-02	5.61E-03	
4 Iron	NA	ND	0.00E+00	
5 Lead	8.01E-05	ND	0.00E+00	
6 Manganese	1.52E-05	8.00E-03	1.57E-03	
7 Zinc	1.60E-04	6.00E-02	2.21E-03	
				3.87E-02

TABLE B-216. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE ADULT.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.10E-03	9.50E-04	9.59E-01	
2 Cadmium	6.51E-05	5.00E-05	1.08E+00	
3 Copper	6.76E-03	2.20E-02	2.55E-01	
4 Iron	NA	ND	0.00E+00	
5 Lead	8.55E-04	ND	0.00E+00	
6 Manganese	2.38E-03	8.00E-03	2.47E-01	
7 Zinc	2.65E-02	6.00E-02	3.66E-01	
				2.91E+00

TABLE B-217. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE ADULT

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	6.93E-06	9.50E-04	6.04E-03	
2 Cadmium	3.01E-06	5.00E-05	4.99E-02	
3 Copper	4.22E-05	2.20E-02	1.59E-03	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.36E-04	ND	0.00E+00	
6 Manganese	6.47E-05	8.00E-03	6.70E-03	
7 Zinc	7.23E-05	6.00E-02	9.98E-04	
				6.52E-02

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TABLE B-218. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE ADULT.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.32E-06	9.50E-04	2.02E-03	
2 Cadmium	3.59E-08	5.00E-05	5.95E-04	
3 Copper	2.31E-05	2.20E-02	8.70E-04	
4 Iron	1.93E-06	ND	0.00E+00	
5 Lead	3.26E-06	ND	0.00E+00	
6 Manganese	1.66E-07	8.00E-03	1.72E-05	
7 Zinc	5.18E-06	6.00E-02	7.15E-05	
				3.58E-03

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TABLE B-219. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE ADULT.

CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
1 Arsenic	9.92E-01	0.00E+00	9.92E-01
2 Cadmium	1.13E+00	0.00E+00	1.13E+00
3 Copper	2.63E-01	0.00E+00	2.63E-01
4 Iron	0.00E+00	0.00E+00	0.00E+00
5 Lead	0.00E+00	0.00E+00	0.00E+00
6 Manganese	2.55E-01	1.88E-02	2.74E-01
7 Zinc	3.69E-01	0.00E+00	3.69E-01
TOTAL	3.01E+00	1.88E-02	3.03E+00

WORST CASE NONCARCINOGENIC RISKS TO
AN ADULT
TABLES B-220 THROUGH B-229

TABLE B-220. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE ADULT

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	3.21E-06	ND	0.00E+00	
2 Cadmium	1.45E-05	ND	0.00E+00	
3 Copper	4.67E-05	ND	0.00E+00	
4 Iron	2.53E-05	ND	0.00E+00	
5 Lead	2.23E-05	ND	0.00E+00	
6 Manganese	7.73E-07	1.40E-04	4.57E-03	
7 Zinc	1.02E-05	ND	0.00E+00	
				4.57E-03

TABLE B-221. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE
ADULT

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	8.32E-07	ND	0.00E+00	
2 Cadmium	7.12E-07	ND	0.00E+00	
3 Copper	3.94E-05	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	4.13E-05	ND	0.00E+00	
6 Manganese	6.72E-06	1.40E-04	3.98E-02	
7 Zinc	3.31E-05	ND	0.00E+00	
				3.98E-02

TABLE B-222. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE ADULT

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.18E-04	9.50E-04	1.90E-01	
2 Cadmium	2.40E-06	5.00E-05	3.98E-02	
3 Copper	5.31E-03	2.20E-02	2.00E-01	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.03E-03	ND	0.00E+00	
6 Manganese	6.71E-05	8.00E-03	6.95E-03	
7 Zinc	2.79E-03	6.00E-02	3.85E-02	
				4.75E-01

TABLE B-223. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.11E-03	9.50E-04	1.84E+00	
2 Cadmium	1.37E-04	5.00E-05	2.27E+00	
3 Copper	1.01E-02	2.20E-02	3.80E-01	
4 Iron	NA	ND	0.00E+00	
5 Lead	2.44E-03	ND	0.00E+00	
6 Manganese	3.56E-03	8.00E-03	3.69E-01	
7 Zinc	5.20E-02	6.00E-02	7.18E-01	
				5.58E+00

TABLE B-224. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.65E-05	9.50E-04	2.31E-02	
2 Cadmium	1.36E-05	5.00E-05	2.25E-01	
3 Copper	7.53E-04	2.20E-02	2.84E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	8.77E-04	ND	0.00E+00	
6 Manganese	1.43E-04	8.00E-03	1.48E-02	
7 Zinc	6.31E-04	6.00E-02	8.71E-03	
				3.00E-01

TABLE B-225. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.39E-05	9.50E-04	1.21E-02	
2 Cadmium	6.52E-07	5.00E-05	1.08E-02	
3 Copper	1.06E-04	2.20E-02	3.99E-03	
4 Iron	1.31E-05	ND	0.00E+00	
5 Lead	1.26E-05	ND	0.00E+00	
6 Manganese	4.34E-07	8.00E-03	4.50E-05	
7 Zinc	2.36E-05	6.00E-02	3.26E-04	
				2.73E-02

TABLE B-226. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.25E-04	9.50E-04	1.09E-01	
2 Cadmium	7.67E-06	5.00E-05	1.27E-01	
3 Copper	NA	2.20E-02	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.99E-03	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	2.41E-01	6.00E-02	3.33E+00	
				3.56E+00

TABLE B-227. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE
ADULT

	CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1	Arsenic	4.66E-02	9.50E-04	4.06E+01	
2	Cadmium	4.00E-04	5.00E-05	6.63E+00	
3	Copper	5.14E-04	2.20E-02	1.94E-02	
4	Iron	1.77E-02	ND	0.00E+00	
5	Lead	7.43E-04	ND	0.00E+00	
6	Manganese	1.23E+00	8.00E-03	1.27E+02	
7	Zinc	7.14E-03	6.00E-02	9.86E-02	
					1.75E+02

TABLE B-228. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE ADULT.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	8.24E-04	9.50E-04	7.19E-01	
2 Cadmium	6.08E-05	5.00E-05	1.01E+00	
3 Copper	8.10E-03	2.20E-02	3.05E-01	
4 Iron	NA	ND	0.00E+00	
5 Lead	4.24E-04	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	4.48E-02	6.00E-02	6.19E-01	
				2.65E+00

TABLE B-229. CHEMICAL-SPECIFIC RISK FOR WORST CASE ADULT.

	CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
	1 Arsenic	4.35E+01	0.00E+00	4.35E+01
	2 Cadmium	1.03E+01	0.00E+00	1.03E+01
	3 Copper	9.37E-01	0.00E+00	9.37E-01
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	1.28E+02	4.43E-02	1.28E+02
	7 Zinc	4.81E+00	0.00E+00	4.81E+00
TOTAL		1.87E+02	4.43E-02	1.87E+02

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REPRESENTATIVE NONCARCINOGENIC LIFETIME
RISKS TO A PERSON FROM MANLOVE
TABLES B-230 THROUGH B-239

TABLE B-230. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.22E-05	9.50E-04	4.44E-02	
2 Cadmium	3.93E-07	5.00E-05	7.86E-03	
3 Copper	2.20E-04	2.20E-02	1.00E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.18E-04	ND	0.00E+00	
6 Manganese	2.25E-05	8.00E-03	2.81E-03	
7 Zinc	2.36E-04	6.00E-02	3.93E-03	
				6.90E-02

TABLE B-231. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	7.03E-07	ND	0.00E+00	
2 Cadmium	1.06E-06	ND	0.00E+00	
3 Copper	1.72E-05	ND	0.00E+00	
4 Iron	5.22E-06	ND	0.00E+00	
5 Lead	1.02E-05	ND	0.00E+00	
6 Manganese	1.70E-07	1.40E-04	1.21E-03	
7 Zinc	4.74E-06	ND	0.00E+00	
				1.21E-03

TABLE B-232. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.02E-07	ND	0.00E+00	
2 Cadmium	1.46E-07	ND	0.00E+00	
3 Copper	2.05E-06	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	5.95E-06	ND	0.00E+00	
6 Manganese	2.83E-06	1.40E-04	2.02E-02	
7 Zinc	3.51E-06	ND	0.00E+00	
				2.02E-02

TABLE B-233. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	6.81E-06	9.50E-04	7.17E-03	
2 Cadmium	2.93E-08	5.00E-05	5.86E-04	
3 Copper	4.00E-06	2.20E-02	1.82E-04	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	5.00E-06	ND	0.00E+00	
6 Manganese	1.10E-06	8.00E-03	1.38E-04	
7 Zinc	1.32E-05	6.00E-02	2.20E-04	
				8.29E-03

TABLE B-234. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.28E-03	9.50E-04	1.35E+00	
2 Cadmium	7.58E-05	5.00E-05	1.52E+00	
3 Copper	7.85E-03	2.20E-02	3.57E-01	
4 Iron	NA	ND	0.00E+00	
5 Lead	9.95E-04	ND	0.00E+00	
6 Manganese	2.78E-03	8.00E-03	3.48E-01	
7 Zinc	3.08E-02	6.00E-02	5.13E-01	
				4.08E+00

TABLE B-235. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	8.84E-06	9.50E-04	9.31E-03	
2 Cadmium	1.77E-06	5.00E-05	3.54E-02	
3 Copper	6.07E-06	2.20E-02	2.76E-04	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	4.54E-05	ND	0.00E+00	
6 Manganese	2.51E-05	8.00E-03	3.14E-03	
7 Zinc	3.19E-05	6.00E-02	5.32E-04	
				4.87E-02

TABLE B-236. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	7.17E-06	9.50E-04	7.55E-03	
2 Cadmium	3.12E-06	5.00E-05	6.24E-02	
3 Copper	4.36E-05	2.20E-02	1.98E-03	
4 Iron	NA	ND	0.00E+00	
5 Lead	1.41E-04	ND	0.00E+00	
6 Manganese	6.69E-05	8.00E-03	8.36E-03	
7 Zinc	7.49E-05	6.00E-02	1.25E-03	
				8.15E-02

TABLE B-237. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.27E-06	9.50E-04	2.39E-03	
2 Cadmium	3.55E-08	5.00E-05	7.10E-04	
3 Copper	2.30E-05	2.20E-02	1.05E-03	
4 Iron	1.93E-06	ND	0.00E+00	
5 Lead	3.14E-06	ND	0.00E+00	
6 Manganese	1.44E-07	8.00E-03	1.80E-05	
7 Zinc	4.97E-06	6.00E-02	8.28E-05	
				4.25E-03

TABLE B-238. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR REPRESENTATIVE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.12E-10	9.50E-04	4.34E-07	
2 Cadmium	5.49E-11	5.00E-05	1.10E-06	
3 Copper	2.74E-10	2.20E-02	1.25E-08	
4 Iron	2.61E-09	ND	0.00E+00	
5 Lead	2.67E-10	ND	0.00E+00	
6 Manganese	4.70E-09	8.00E-03	5.88E-07	
7 Zinc	9.95E-10	6.00E-02	1.66E-08	
				2.15E-06

TABLE B-239. CHEMICAL-SPECIFIC RISK FOR REPRESENTATIVE LIFETIME IN MANLOVE

	CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
	1 Arsenic	1.42E+00	0.00E+00	1.42E+00
	2 Cadmium	1.62E+00	0.00E+00	1.62E+00
	3 Copper	3.70E-01	0.00E+00	3.70E-01
	4 Iron	0.00E+00	0.00E+00	0.00E+00
	5 Lead	0.00E+00	0.00E+00	0.00E+00
	6 Manganese	3.62E-01	2.14E-02	3.83E-01
	7 Zinc	5.19E-01	0.00E+00	5.19E-01
TOTAL		4.29E+00	2.14E-02	4.31E+00

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WORST CASE NONCARCINOGENIC LIFETIME RISKS
FOR A PERSON FROM MANLOVE
TABLES B-240 THROUGH B-252

TABLE B-240. PATHWAY-SPECIFIC RISK--SOIL INGESTION FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.61E-04	9.50E-04	1.69E-01	
2 Cadmium	1.77E-06	5.00E-05	3.54E-02	
3 Copper	3.93E-03	2.20E-02	1.79E-01	
4 Iron	NA	ND	0.00E+00	
5 Lead	7.63E-04	ND	0.00E+00	
6 Manganese	4.96E-05	8.00E-03	6.20E-03	
7 Zinc	2.06E-03	6.00E-02	3.43E-02	
				4.24E-01

TABLE B-241. PATHWAY-SPECIFIC RISK--INHALATION OF OUTDOOR AIR FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	4.49E-06	ND	0.00E+00	
2 Cadmium	2.02E-05	ND	0.00E+00	
3 Copper	6.53E-05	ND	0.00E+00	
4 Iron	3.54E-05	ND	0.00E+00	
5 Lead	3.12E-05	ND	0.00E+00	
6 Manganese	1.08E-06	1.40E-04	7.71E-03	
7 Zinc	1.42E-05	ND	0.00E+00	
				7.71E-03

TABLE B-242. PATHWAY-SPECIFIC RISK--INHALATION OF INDOOR AIR FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	7.71E-07	ND	0.00E+00	
2 Cadmium	6.60E-07	ND	0.00E+00	
3 Copper	3.66E-05	ND	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	3.83E-05	ND	0.00E+00	
6 Manganese	6.24E-06	1.40E-04	4.46E-02	
7 Zinc	3.07E-05	ND	0.00E+00	
				4.46E-02

TABLE B-243. PATHWAY-SPECIFIC RISK--SEDIMENT INGESTION FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.70E-05	9.50E-04	1.79E-02	
2 Cadmium	4.40E-08	5.00E-05	8.80E-04	
3 Copper	5.96E-06	2.20E-02	2.71E-04	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	7.63E-06	ND	0.00E+00	
6 Manganese	1.28E-06	8.00E-03	1.60E-04	
7 Zinc	2.13E-05	6.00E-02	3.55E-04	
				1.96E-02

TABLE B-244. PATHWAY-SPECIFIC RISK--VEGETABLE CONSUMPTION FOR WORST CASE LIFETIME IN HANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.45E-03	9.50E-04	2.58E+00	
2 Cadmium	1.60E-04	5.00E-05	3.20E+00	
3 Copper	1.17E-02	2.20E-02	5.32E-01	
4 Iron	NA	ND	0.00E+00	
5 Lead	2.84E-03	ND	0.00E+00	
6 Manganese	4.14E-03	8.00E-03	5.18E-01	
7 Zinc	6.04E-02	6.00E-02	1.01E+00	
				7.83E+00

TABLE B-245. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SEDIMENTS FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.21E-05	9.50E-04	2.33E-02	
2 Cadmium	2.67E-06	5.00E-05	5.34E-02	
3 Copper	9.03E-06	2.20E-02	4.10E-04	
4 Iron	0.00E+00	ND	0.00E+00	
5 Lead	6.93E-05	ND	0.00E+00	
6 Manganese	2.92E-05	8.00E-03	3.65E-03	
7 Zinc	5.17E-05	6.00E-02	8.62E-04	
				8.16E-02

TABLE B-246. PATHWAY-SPECIFIC RISK--DERMAL CONTACT WITH SOIL FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	2.74E-05	9.50E-04	2.88E-02	
2 Cadmium	1.41E-05	5.00E-05	2.82E-01	
3 Copper	7.79E-04	2.20E-02	3.54E-02	
4 Iron	NA	ND	0.00E+00	
5 Lead	9.08E-04	ND	0.00E+00	
6 Manganese	1.48E-04	8.00E-03	1.85E-02	
7 Zinc	6.53E-04	6.00E-02	1.09E-02	
				3.76E-01

TABLE 247. PATHWAY-SPECIFIC RISK--INGESTION OF IRRESPIRABLE PARTICLES
FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.37E-05	9.50E-04	1.44E-02	
2 Cadmium	6.51E-07	5.00E-05	1.30E-02	
3 Copper	1.03E-04	2.20E-02	4.68E-03	
4 Iron	1.31E-05	ND	0.00E+00	
5 Lead	1.19E-05	ND	0.00E+00	
6 Manganese	3.85E-07	8.00E-03	4.81E-05	
7 Zinc	2.18E-05	6.00E-02	3.63E-04	
				3.25E-02

TABLE B-248. PATHWAY-SPECIFIC RISK--DERMAL EXPOSURE DURING SWIMMING FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
Arsenic	1.03E-09	9.50E-04	1.08E-06	
Cadmium	2.06E-10	5.00E-05	4.12E-06	
Copper	6.86E-10	2.20E-02	3.12E-08	
Iron	4.29E-09	ND	0.00E+00	
Lead	8.57E-10	ND	0.00E+00	
Manganese	6.14E-09	8.00E-03	7.68E-07	
Zinc	3.57E-09	6.00E-02	5.95E-08	
				6.06E-06

TABLE B-249. PATHWAY-SPECIFIC RISK--MEAT CONSUMPTION FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.79E-04	9.50E-04	1.88E-01	
2 Cadmium	1.10E-05	5.00E-05	2.20E-01	
3 Copper	NA	2.20E-02	0.00E+00	
4 Iron	NA	ND	0.00E+00	
5 Lead	2.86E-03	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	3.46E-01	6.00E-02	5.77E+00	
				6.18E+00

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TABLE B-250. PATHWAY-SPECIFIC RISK--DRINKING WATER FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	5.24E-02	9.50E-04	5.52E+01	
2 Cadmium	4.50E-04	5.00E-05	9.00E+00	
3 Copper	5.79E-04	2.20E-02	2.63E-02	
4 Iron	1.99E-02	ND	0.00E+00	
5 Lead	8.36E-04	ND	0.00E+00	
6 Manganese	1.38E+00	8.00E-03	1.72E+02	
7 Zinc	8.04E-03	6.00E-02	1.34E-01	
				2.37E+02

TABLE B-251. PATHWAY-SPECIFIC RISK--GRAIN CONSUMPTION FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	CDI MG/KG/DAY	RFD 1/(MG/KG/DAY)	HI UNITLESS	PATHWAY HI UNITLESS
1 Arsenic	1.18E-03	9.50E-04	1.24E+00	
2 Cadmium	8.70E-05	5.00E-05	1.74E+00	
3 Copper	1.16E-02	2.20E-02	5.27E-01	
4 Iron	NA	ND	0.00E+00	
5 Lead	6.07E-04	ND	0.00E+00	
6 Manganese	NA	8.00E-03	0.00E+00	
7 Zinc	6.42E-01	6.00E-02	1.07E+01	
				1.42E+01

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TABLE B-252. CHEMICAL-SPECIFIC RISK FOR WORST CASE LIFETIME IN MANLOVE.

CHEMICAL	HI-ING UNITLESS	HI-INH UNITLESS	TOTAL HI UNITLESS
1 Arsenic	5.94E+01	0.00E+00	5.94E+01
2 Cadmium	1.45E+01	0.00E+00	1.45E+01
3 Copper	1.30E+00	0.00E+00	1.30E+00
4 Iron	0.00E+00	0.00E+00	0.00E+00
5 Lead	0.00E+00	0.00E+00	0.00E+00
6 Manganese	1.73E+02	5.23E-02	1.73E+02
7 Zinc	1.77E+01	0.00E+00	1.77E+01
TOTAL	2.66E+02	5.23E-02	2.66E+02